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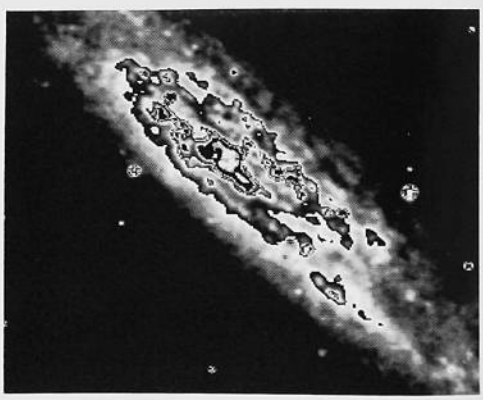

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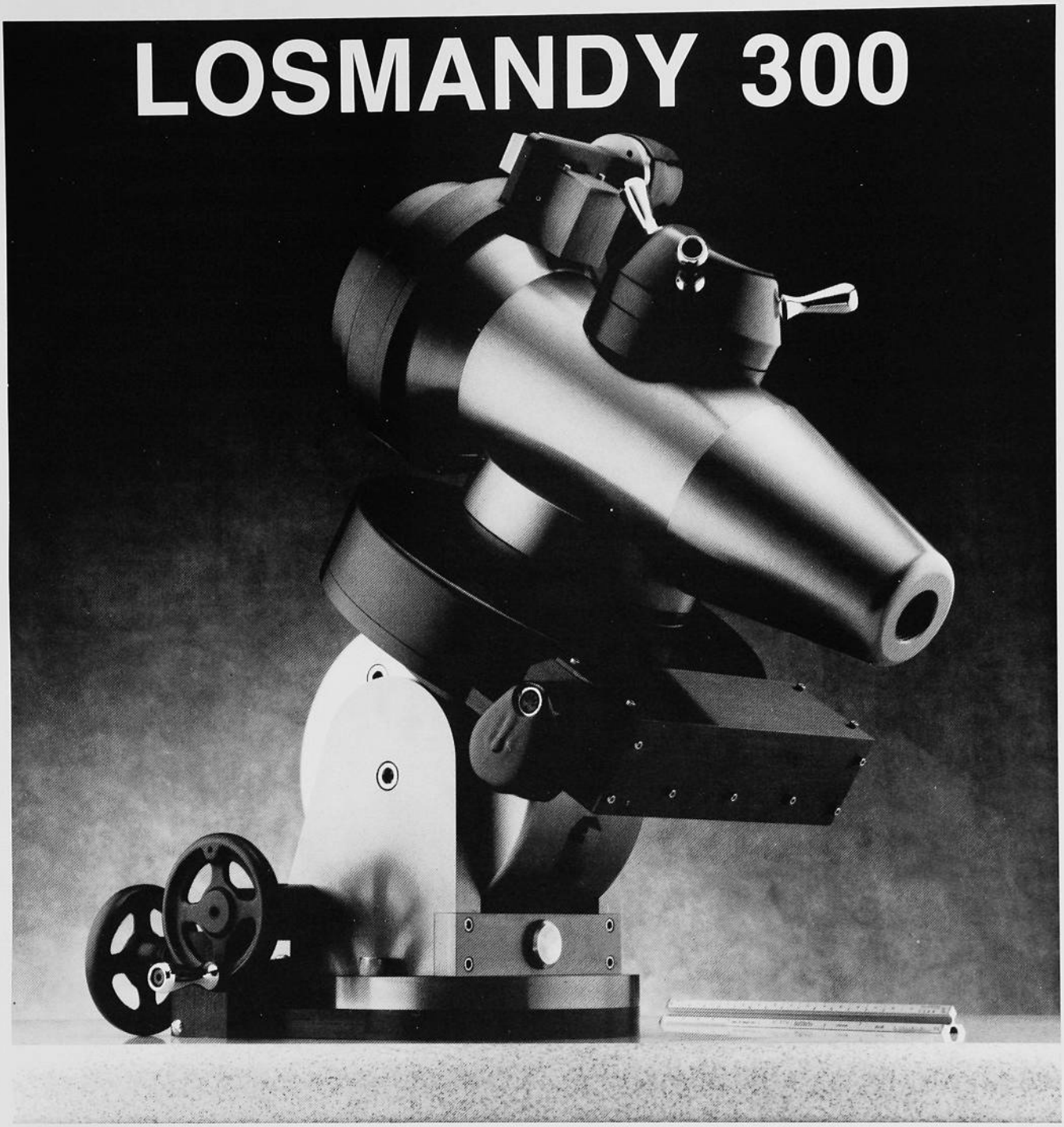

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Opposite page: The Vela Supernova remnant photographed by Bernd Koch, 8-inch f/1.7 Schmidt camera, hypered Tech Pan film, Wratten #92 filter, 43-minute exposure.

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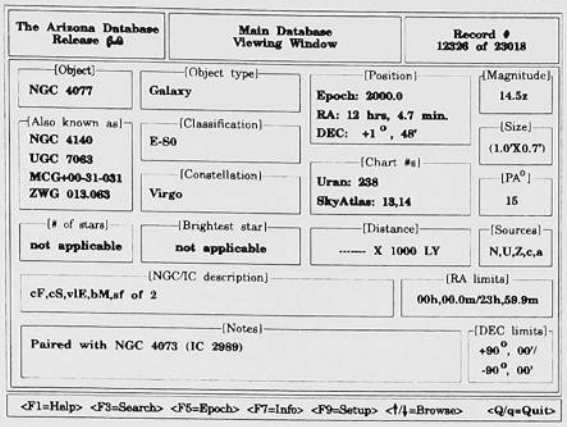
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[Size] (1.0'X0.7')
[Constellation] Virgo
[Chart #s] Uran: 238 SkyAtlas: 13,14
[PA°] 15
[# of stars] not applicable
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[Distance] ..... X 1000 LY
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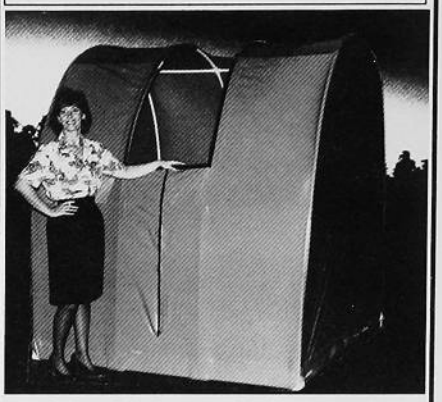

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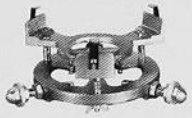

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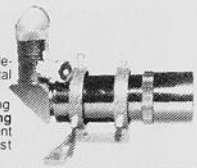

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Letters to *Deep Sky*

What's Happening in Deep Sky Astronomy?

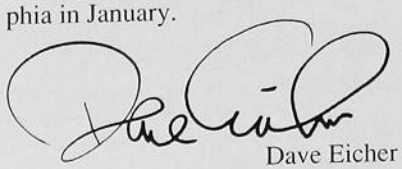
by the readers of *Deep Sky*

AT THE EYEPIECE

Welcome to chilly winter here in the northern hemisphere and another issue of *Deep Sky*. This winter we'll examine the star clusters discovered by Clyde Tombaugh, explore faint galaxies and planetary nebulae in Lynx, and get a lesson on how to sketch planetary nebulae at the eyepiece. Our departments report on the unusual, fun year at the Texas Star Party, unravel a mystery involving the bright nebula NGC 7129/33, scan the Lacerta Milky Way, discover some winter challenges for binoculars and telescopes, and receive another lesson from in-house expert Brian Skiff on good magnitudes and bad magnitudes.

Responding to what you've asked for, we've increased the number of pages devoted to book reviews pertaining to deep-sky observing and congratulate Mark Coco for the fine job he has done with this column. This issue Mark reviews Newton and Teece's *Guide to Amateur Astronomy*, John Kozak's *Deep-Sky Objects for Binoculars*, Wil Tirion's *Bright Star Atlas 2000.0*, John Mosley's *The Christmas Star*, Arp and Madore's *Catalogue of Southern Peculiar Galaxies and Associations*, *Star and Planet Spotting* by Peter Lancaster-Brown, and Michael Porcellino's *Through the Telescope*. That should keep you busy reading about the stars even if it's too cold to go out and look at them firsthand.

I'll look forward to seeing and talking with some of you at the upcoming AAS meeting in Philadelphia in January.



Dave Eicher

Focus on NGC 6946

Dear Mr. Eicher / Ernie Ostuno's interesting article "Galaxies along the Summer Milky Way" in *Deep Sky* #31 commented on the spiral galaxy NGC 6946. As this galaxy is always on my observing schedule, I would like to add to Mr. Ostuno's correct description.

Because I hunt for supernovae, NGC 6946's generous record of events keeps my attention. I rarely miss the opportunity to scan its field. In all, six supernovae have been observed in this galaxy; these include 1917a, 1939c, 1948b, 1968d, 1969p, and 1980k. What Mr. Ostuno says is true — identifying a supernova without a finder chart is difficult. The field is rich in faint stars due to its low galactic latitude.

The same issue of *Deep Sky* mentions the *Supernova Search Charts and Handbook* which Gregg Thompson and I produced. In preparing to draw the field for NGC 6946, I examined the galaxy's image on the *Palomar Sky Survey* and found that areas of dark matter intrude closely upon the galaxy. Harold D. Ables' *Optical Study of Nearby Galaxies*, published in 1968, reported extinction in blue of 1.75 magnitudes for NGC 6946. The opacity of some of these neighboring dark regions appears so great that if the galaxy was only slightly differently placed, that fine record of supernovae discoveries might not exist. Knowing the severe effect of extinction on the galaxy, I was especially pleased to see its spiral structure as I observed with a 16-inch reflector at high magnification under excellent conditions.

To draw a search chart, we first traced a photograph of each galaxy and followed with careful visual observations to correct the drawing. As I recall, it took more than a dozen hours at the telescope to examine and modify the NGC 6946 field tracing. The most time-consuming effort was made for IC 342, which required seventeen hours of observation to complete. — *James Bryan, The Nancy Lavender Astronomical Observatory, 605 San Gabriel Overlook, Georgetown, Texas 78628*

The Value of Messier Marathons

Dear Dave / Yet another letter in defense of Messier Marathons. In their letters both Dick Suiter and Stephen M. Hopkins missed a very good, almost scientific, reason to conduct a Messier Marathon. To put it in its most simple terms, it's a great way to find out how the universe is put together.

From starting out in the evening with the local cluster of galaxies, to ending with the encircling ring of globular clusters around the center of the Milky Way, the Messier Marathon is perhaps the best way for a beginner to grasp the construction of the heavens and develop a clear understanding of all four seasons of sky. This not only provides an outstanding base of experience and information to build one's astronomical experiences on, but also inspires a sense of awe of the beauty and majesty of the night sky. — *Bob Bunge, 295 Tappan Street, Apt. A, Columbus, Ohio 43201*

Return from Star-vation

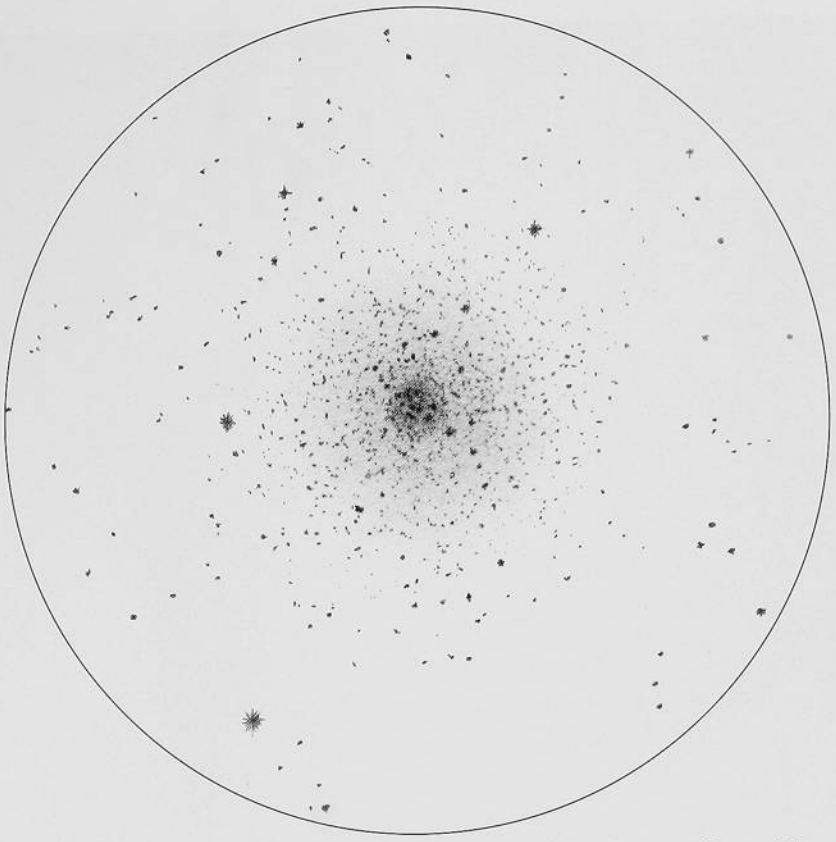
Dear Dave / After a nine-month "starvation" occasioned by relocation from Alberta and the erection of a new observing shelter for my C-11 in Saskatchewan, I am now happy to resume my observing and drawing projects. And *Deep Sky* is once again a faithful companion and treasury of challenging deep-sky objects. I have worked through the Summer issue (#31) and have recently viewed the 10 or so objects I had not yet seen.

Ernie Ostuno's Milky Way list, Dennis Casper's Draco galaxies, and Ling's efforts are marvels of fine observing, drawings, and descriptions. However, I find it most frustrating and time consuming not having coordinates for objects not listed in *Sky Catalogue 2000.0* or plotted on *Uranometria 2000.0*. I am not sure that many observers actually have access to the *MCG*, *UGC*, or *Zwicky* catalogs. It is not much help to be told that a galaxy is a very difficult object in such and such a telescope, or can be found 15' northwest of a given

star. At one time *Deep Sky* regularly provided tables of data for all objects discussed in the text. In the past I have found these tables helpful, freeing up more of my time for observing.

Ostuno mentioned that he had not observed IC 1296, the magnitude 15.6 galaxy just northwest of the Ring Nebula, even with apertures up to 20 inches. I have seen this elusive galaxy twice, once at Cochrane, Alberta, on July 8, 1988, and again just last week using my new observatory with the C-11. I used an eyepiece that yielded 418x and placed M57 just outside the field. An equal challenge — I owe this one to Alister Ling — is IC 4617, the 15th-magnitude galaxy on the northeastern edge of M13. It, too, was visible in July 1988 and again last week. *— Lucian J. Kemble, The Franciscans St. Michael's Retreat, Box 220, Lumsden, Saskatchewan, S0G 3C0 Canada.*

Your editor also feels it is unfortunate that the amount of data provided with feature articles has dropped. As many readers know, however, Deep Sky *is a magazine that relies on a lightning-fast production schedule and minimum effort in the production department. Otherwise it would not exist. I am now Associate Editor of* ASTRONOMY, *and have even less time to devote to* Deep Sky *than in the past. The responsibility for providing accurate, complete data rests with authors. I cannot compile it all myself for every article — that would require many hours per issue before any editing or production work could begin! Brian Skiff and I are presently working on a set of instructions for authors on how to use the correct data, formulate it in tables, and submit them, preferably camera-ready. Within several issues I hope you will see pages again loaded with tabular data. — D. Eicher.*



Can you identify the object in this sketch by Australian observer Gregg Thompson? It was made with a 12.5-inch f/5 reflector at 176x; the field measures 25′.

The Fine Points of Sketching

Dear Dave / In issue #30 Gerd Bahr-Vollrath brought up some excellent points on sketching deep-sky objects. Because I work in the negative method — black stars on white sky — I know the trouble one can have with the glare from the white drawing surface. I have approached resolving this problem by cutting a hole the size of my drawing circle in a piece of black construction paper and overlaying this on my observing form. The only white area left showing is that of the drawing area.

In addition, I use a variably controlled light source. I mounted a clip-on lamp with a 7.5-watt red bulb on my drawing board. I plugged this assembly into an outlet with a variable brightness control. The small appliance bulb produces more than enough light for taking notes and can be adjusted as necessary. I have found little merit in working at light levels so low that eyestrain is induced in order to protect dark adaption. It takes a short period of time for eyes to return to maximum dark adaption if you work with a reasonably dim red bulb. The alternative of using a tape recorder is better suited for those who do not sketch, as it takes the same amount of light to take notes as it does to sketch.

I also appreciated Mr. Bahr-Vollrath's comments on drawing globular clusters. His creativity shows how adventurous deep-sky sketching can be. Globulars offer a challenge to our artistic abilities almost more than any other type of deep-sky object. I've built my method on layering textures that represent the various degrees of visual resolution. These can be classified as smooth, mottled, grainy, and resolved. Each corresponds to a specific drawing technique. Careful layering produces accurate drawings that show a three-dimensional appearance with some globulars.

When drawing these objects one faces the problem of drawing stars that are just barely resolved and those right on the threshold. In cases like this I use a technical pen so that resolved stars in grainy areas can be distinguished. By graphically separating stars the drawings become more useful for later review and comparison.

I certainly hope that *Deep Sky* continues to publish articles discussing different techniques for drawing deep-sky objects. *— Michael E. Sweetman, Sky Crest Observatory, 2961 West Kapata Trail, Tucson, Arizona 85741*

Thompson's Mystery Object Strikes Again

Dear Dave / Have your readers ever heard of a double globular? Why is this object double? When viewed in a 6-inch or larger telescope at medium to high powers, the brighter core stars in this object are well compacted against a background haze that rises so sharply at the core that it makes the core itself appear like a globular cluster. The impres-

Are the galaxies NGC 4725 and NGC 4712 gravitationally related? No, but they still make a beautiful picture, as demonstrated by James R. Foster of Hollywood, California. Foster's photo (above) was made with an 11-inch f/10 SCT, hypered Tech Pan, and a 165-minute exposure. NGC 4725 is the larger galaxy. Another wonderful Foster photo depicts M83 (left). It is a 145-minute exposure with the same setup.

sion I get is one globular superposed against another in the distant background! Surprisingly, this object's core appears notably yellowish in low-power eyepieces that are not heavily tinted with blue achromatic coatings. The yellowish core stars make the outlying members appear slightly bluish. To show such color in a 6-inch scope, therefore, the individual stars must be rather bright.

The accompanying high-accuracy drawing was made by myself with a 12.5-inch reflector at 176x, resulting in a true field of 25'. The seeing was less than 1" and the transparency and overall sky darkness were quite good.

Photographs of this globular never reveal its unique visual appearance. How many readers know this object and have witnessed the color and structure of its unusual core? — *Gregg D. Thompson, Springwood Observatory, 7 Strover Court, Springwood, Queensland, Australia 4127*

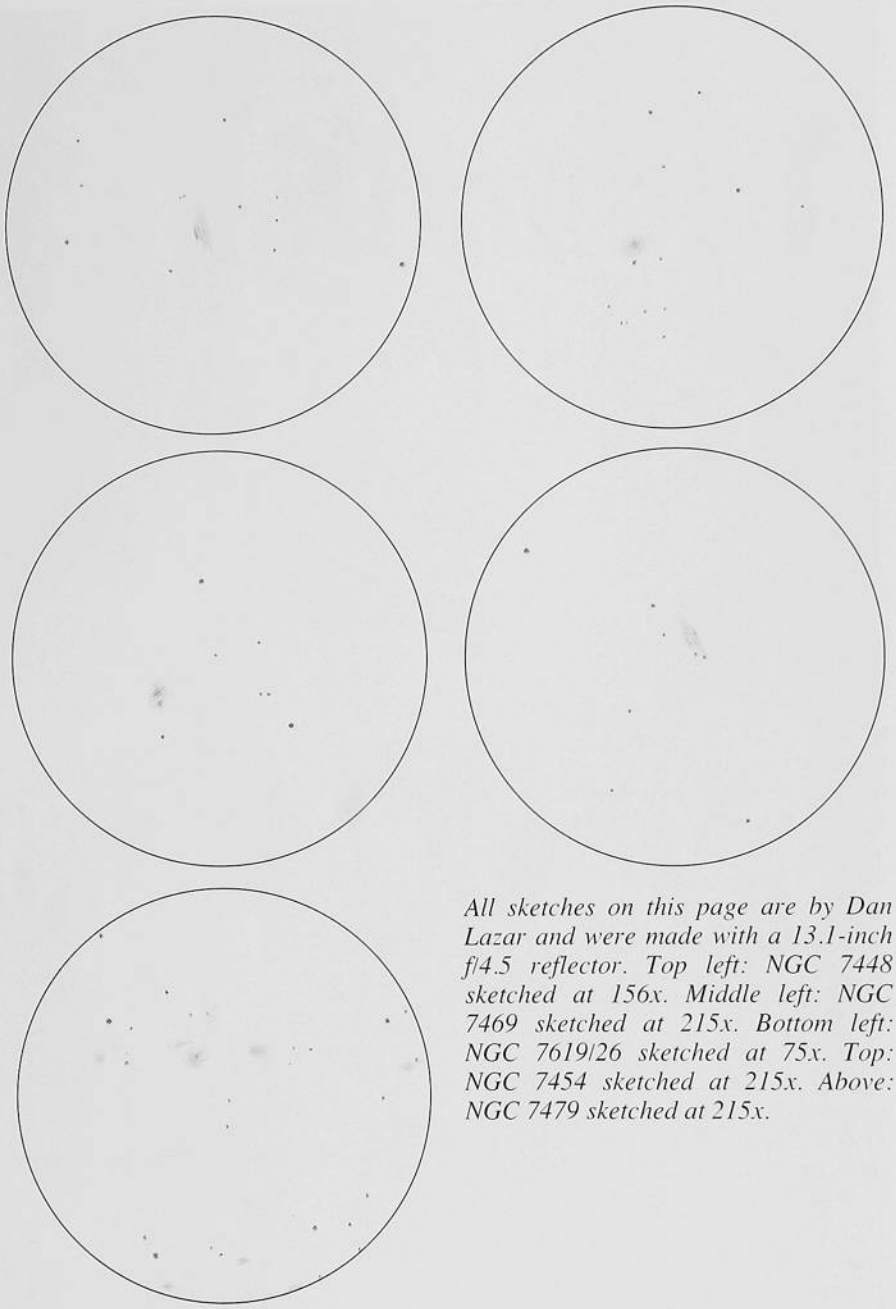
Cosmic Dance of the Galaxies

Dear Dave / I am sending you three pictures of galaxies I have photographed during the past three months. Each of the photos was made with an 11-inch f/10 SCT, hypered Tech Pan film, and relatively long exposures. One photo shows the galaxies NGC 4725 and NGC 4712 and, extremely lightly, what appears to be a faint arc of material between the two objects. Could these galaxies be connected or could the material have been drawn off by tidal interaction?

Another photo shows the bright spiral NGC 5364 in eastern Virgo. The limiting magnitude in this photo is somewhere around 17th or 18th magnitude. I identified all of the objects in this photo except for a mystery concerning IC 958, which should lie 1/4 of the way between the 14th-magnitude galaxy NGC 5360 and NGC 5364 itself. I do not see it at its designated position, however.

By looking at a slide version of the photo I see a faint object at approximately 13h56.8m, whereas IC 958 is supposed to be at 13h55.8m. Could this be an error in the *RNGC?* Can any reader confirm the real identity of IC 958? — *James R. Foster, 1335 North Poinsettia Place, Apt. 4, Hollwood, California 90046*

Galaxies NGC 4725 and NGC 4712 are not physically related, as their radial velocities show they are nowhere near each other (NGC 4725 is much closer). The photo is so pretty I wanted to run it anyway. On the identity of IC 958, can we hear from one of you RNGC slueths out there? — D. Eicher.



All sketches on this page are by Dan Lazar and were made with a 13.1-inch f/4.5 reflector. Top left: NGC 7448 sketched at 156x. Middle left: NGC 7469 sketched at 215x. Bottom left: NGC 7619/26 sketched at 75x. Top: NGC 7454 sketched at 215x. Above: NGC 7479 sketched at 215x.

Greetings from Auroraeland

Dear David / Greetings from the land of the aurorae. In reply to various articles mentioning some great deep-sky objects, I am sending some copies of galaxy drawings I have made, which I hope you and the readers enjoy. All observations were made with a 13.1-inch scope at various powers.

NGC 7448 was easily found in less than perfect skies. It appears to be elongated and measures about 4' by 1.5' across, lying between two 10th-magnitude field stars. The galaxy is condensed along the western edge, and appears to have no nuclear area.

NGC 7479 is elongated about 4' by 2' along a north-south plane. Two 11th-magnitude field stars lie along the galaxy's northwest edge. This object is easily found and was recognized instantly in a sparse starfield.

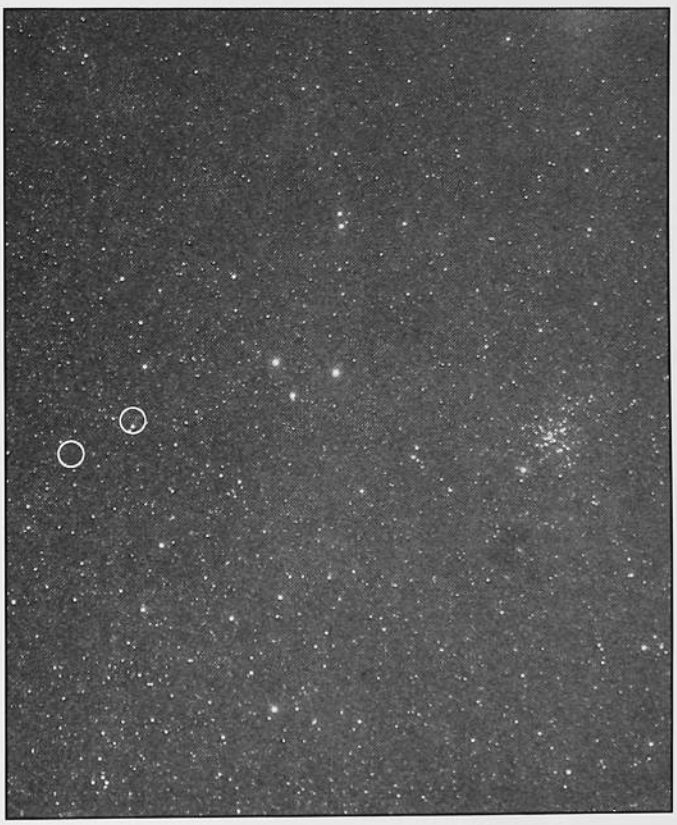
The NGC 7619 galaxy group consists of three bright galaxies, NGC 7617, NGC 7619, and NGC 7626. The group reminds me of a miniature version of the M84-M86 group in the center of the Virgo cluster. — *Dan Lazar, 936 Fifth Street N.W., Calgary, Alberta, T2N 1R2 Canada* □

Tracking down the
Tombaugh Clusters

Little-known and rarely observed, a group of attractive open clusters was discovered by none other than Clyde Tombaugh

by Max Paul Radloff

J. L. E. Dreyer's *New General Catalogue* and his two supplementary volumes of the *Index Catalogue* have long been a rich source of material for amateur astronomers assembling a list of targets for an evening's observing. Despite the wealth of listings in Dreyer's catalogs, they contain only a tiny fraction of the objects in the sky, and many objects that are of interest in amateur-sized instruments were yet undiscovered when the second supplement appeared in 1908. Astronomical discovery happened at such a pace in the 20th century that by the time *A Master List of Nonstellar Optical Astronomical Objects* appeared in 1980, it contained about 185,000 entries. Recent years have seen the advent of automatic plate measuring machines like those at the Space Telescope Science Institute. Now the number of catalogued nonstellar objects is nearly four million, and if the catalogs were extended to the limiting magnitude of the plates, the number of objects would reach a billion.



Virtually all these objects are very faint galaxies, far beyond amateur observation, but among this multitude of objects are many that make interesting viewing in backyard telescopes. This article begins a series that will explore the group of non-NGC objects most accessible to amateurs, open clusters. Of the over 1,200 open clusters discovered in our galaxy to date, only about half are in the *NGC*. The non-NGC clusters range from easy naked eye objects like the Pleiades and the Coma Berenices cluster to clusters that will challenge even the users of large telescopes. Some will already be familiar to many observers, while others will have been observed visually only a few times, or perhaps not at all. The listings in *Sky Catalogue 2000. 0* and the additional clusters plotted in *Uranometria 2000. 0* (*U2*) have added many objects beyond the *NGC* to amateur observing lists, but there are still quite a few clusters found in neither of these sources that are visible in small and medium-sized scopes.

We will start the exploration of the non-NGC clusters by looking at the five open clusters discovered by Clyde Tombaugh. Any thorough examination of the many plates Tombaugh took in his search for trans-Neptunian planets was certain to reveal new objects. Among these were five open clusters, four of them discoveries and one a known object whose nature was previously uncertain. One of these clusters is a nice sight in small telescopes, and the other four can be seen in scopes with 10 inches or more of aperture. They are challenge objects with a 10-inch telescope, but a couple more inches of aperture should make them easy.

The data in Table 1 were published by Tombaugh in 1941 in the second of his two articles in *Publications of the Astronomical Society of the Pacific* announcing the discovery of the clusters. The data in Table 2 are the latest that could be found in *Sky Catalogue 2000. 0* and articles in professional journals supplemented by personal observations. The data are from professional sources except for the items in parentheses, which are estimates based on personal observations. The estimates and descriptions below were based on my observations with a 10-inch f/6 New-

Circles mark the locations of cluster Tombaugh 1 (northernmost) and Tombaugh 2 on this wide-field photo of Canis Major. Sirius is above center and M41 below center. Photo by Lee C. Coombs (50mm f/1.4 lens, Plus-X film, 5-minute exposure. Opposite page: This closeup shows the locations more precisely. Photo by Craig Crawford and Phil Douglas (8-inch f/10 SCT, Kodacolor 400 film, 10-minute exposure).

A circle marks the position of Tombaugh 4 on this image that includes the emission nebula IC 1805 and the Double Cluster. Photo by Alfred Lilge (4-inch f/6 astrograph, hypered Tech Pan film, 120-minute exposure with a yellow filter).

TABLE 1

	Cluster No.1	Cluster No.2	Cluster No.3	Cluster No.4	Cluster No.5
Position 1855.0 α	$6^h\ 54.2'$	$6^h\ 57.0'$	$1^h\ 42.7'$	$2^h\ 18.2'$	$3^h\ 36.0'$
Position 1855.0 δ	$-20°\ 21'$	$-20°\ 38'$	$+61°\ 08'$	$+61°\ 07'$	$+58°\ 38'$
Position 1940.0 α	$6^h\ 57.9'$	$7^h\ 00.7'$	$1^h\ 48.4'$	$2^h\ 24.5'$	$3^h\ 42.9'$
Position 1940.0 δ	$-20°\ 28'$	$-20°\ 45'$	$+61°\ 33'$	$+61°\ 30'$	$+58°\ 54'$
Class Harvard	c	d	f or g	d	e
Class Trumpler	III 2 p	II 1 p	II 1 r	III 1 p	III 2 m
Angular diameter	5′	2′	3′x 6′	2′x 2.5′	17′
Number of stars	30	25	100	30	30
Magnitude of stars	14 to 16	16 to 17	17	16.5 to 17	14 to 16

This table lists the original data for the Tombaugh clusters as it existed and was published in 1941.

tonian. With this aperture, excellent conditions are needed to see the fainter clusters because the least haze or sky brightness will obscure them. The disparity in the magnitudes between the two tables comes from the fact that Tombaugh used photographic magnitudes which run about two magnitudes fainter than the visual magnitudes used in more recent research.

Tombaugh 1 and **Tombaugh 2** were discovered on plates taken in late 1937 or early 1938. They are located less than a degree from each other in Canis Major, roughly 4° east of M41. Neither of these clusters is plotted in *U2*, but the finder chart shows where to add them to chart 318. Tombaugh 1 is the brighter of the two, and it is easily resolved into a rather small grouping of faint stars, the brightest being about 12th or 13th magnitude. The cluster would not be obvious if you were sweeping the field, but when you specifically look for it, it is clearly distinct from the field stars and easily recognized. The brightest star immediately south of Tombaugh 1 on the *U2* chart is Burnham 572, a double star of magnitudes 6.6 and 10.6 and a separation of 5.2".

Tombaugh 2 is considerably more difficult than Tombaugh 1, and I was able to glimpse it only as a small, very faint nebulous patch that needed averted vision. Observers at a lower latitude who can view this cluster higher in the sky will probably find it somewhat easier than I did. Tombaugh 2 is one of the most distant open clusters, located at the edge of the galactic disk, 19 kpc from the galactic center and 13.2 kpc from us. It is a relatively young cluster, yet at the same time metal-poor like globular clusters and older open clusters. This indicates that the conditions during star formation are not uniform throughout the Galaxy, and at the edge of the Galaxy the environment resembles that of the Magellanic clouds which are metal-poor rather than that of the solar neighborhood where metals are more abundant. Only one open cluster is known to be further from the galactic center than Tombaugh 2 and only three open clusters are known to be further from the galactic plane. Tombaugh 2 is a very rich cluster with stars as bright as 14th magnitude, although the majority of the stars are magnitude 17-20.

The next three clusters were discovered during a survey of the Cassiopeia region made in early 1941. **Tombaugh 3** was actually not a new object but a reobservation of IC 166. It was discovered by the British amateur William Frederick Denning, and it is described in the *Index Catalogue* as "star cluster, nebulous?" Denning was a planetary observer noted for the sharpness of his vision. (He could see fourteen Pleiads with the naked eye.) During the late 19th century he advanced the claim that more planetary detail could be seen in smaller refractors, up to 10 inches in aperture, than in the large refractors then being built at major observatories. Presumably, Denning probably used one of these smaller telescopes for his discovery and it is a tribute to his keen eyesight that he not only found IC 166, but correctly identified it as a cluster. Since IC 166 was not included in any list of known clusters, Tombaugh included it on his list to ensure its appearance in future catalogs of star clusters.

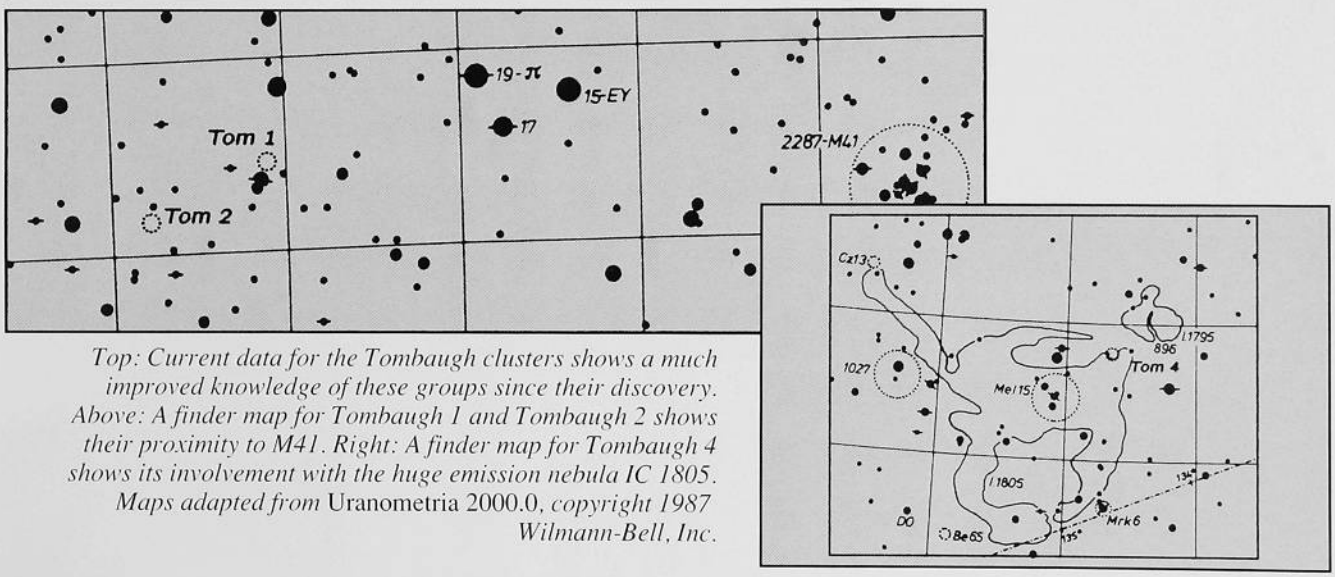
IC 166 is on charts 17 and 37 in *U2* and is located a couple of arcminutes north of the symbol on the chart. On a dark night it can be seen as a diffuse, oval, nebulous patch set in the surrounding field stars, resembling a faint galaxy in appearance. Tombaugh 3 is an intermediate age cluster located in the outer part of the Perseus arm of our galaxy about 3.3 kiloparsecs away. It is a very rich cluster, but quite difficult to resolve in amateur scopes since the brightest stars are 15th magnitude.

Tombaugh 4 is located a few degrees to the east near IC 1805, which is part of a large and complex star-forming region of nebulosity and clusters. The finder chart will show you where to look for it and where to add it to *U2* chart 17. The brightest stars in Tombaugh 4 are 14th magnitude and on the best nights I could just glimpse half a dozen very faint stars. There is no surrounding haze, and not enough stars could be seen to give a strong appearance of a cluster. This is an object that probably requires a 16-inch telescope or larger for a good view. Tombaugh 4 is easily seen in the photo of this region in Hans Veherenberg's *Atlas of Deep Sky Splendors*. On page 41 it is 28mm from the right edge and 22mm below the tick mark for +62°. It is even easier to see in the

This closeup photo of a region in IC 1805 shows Tombaugh 4 spectacularly well. It is visible as a concentration of faint stars near the center. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 60-minute exposure).

TABLE 2

	Cluster No.1	Cluster No.2	Cluster No.3	Cluster No.4	Cluster No.5
Position 2000.0 α	7^h 00.5′	7^h 03.2′	1^h 52.5′	2^h 29.0′	3^h 47.0′
Position 2000.0 δ	−20° 33′	−20° 48′	+61° 50′	+61° 45′	+59° 03′
Constellation	CMa	CMa	Cas	Cas	Cam
Angular diameter	5′	2′	4.5′	2′ x 2.5′	17′
Magnitude	(10.5)	(12)	11.7	(12)	8.4
Number of stars	30	200	185	30	60
Brightest star	(12.5)	15	14.88	14.5	11.62
Magnitude of stars	(12 to 14)	15 to 20	15 to 20	14 to 17	12 to 16
Trumpler class	III 2 p	II 1 p	III 1 r	III 1 p	III 2 m
Distance in parsecs	(~2,000?)	13,200	3,300	(~3,000?)	1,800



Top: Current data for the Tombaugh clusters shows a much improved knowledge of these groups since their discovery. Above: A finder map for Tombaugh 1 and Tombaugh 2 shows their proximity to M41. Right: A finder map for Tombaugh 4 shows its involvement with the huge emission nebula IC 1805. Maps adapted from Uranometria 2000.0, *copyright 1987 Wilmann-Bell, Inc.*

color picture on the facing page. There has been no research done on Tombaugh 4, but its faintness and small size suggest that it is a distant cluster in an outer arm of our Galaxy and that it is not associated with the IC 1805 complex but located behind it.

If you have a small telescope and the first four clusters have been too faint to observe, you will be able to view and enjoy **Tombaugh 5**. It is located in the Milky Way fields of Camelopardalis but is not hard to find because you can star-hop from the IC 1805 region to Stock 23 and then to the group of bright stars west of Tombaugh 5. It is located on chart 39 of *U2*, and it is somewhat smaller than the symbol on the chart. It stands out nicely from the surrounding field and contains a couple dozen stars of 12th and 13th magnitude in addition to many fainter ones. You may be surprised like Tombaugh was that this cluster had been missed in the sweeps by previous observers.

The fields around Tombaugh 5 are nice for sweeping, and there is very wide blue and yellow double a little more than a degree to the north-northwest indicated on the *U2* chart by the two stars that touch the +60° line at approximately 3 hours 42 minutes right ascension. It was discovered by the famous British amateur Rev. T. W. Webb, and another British amateur, T. E. Espin, later discovered two 13th magitude stars about half an arc minute from the brighter star.

The Tombaugh clusters are typical of the non-NGC clusters. They are often faint and a challenge to observe, but a surprisingly bright and interesting object turns up with regularity. Good luck as you try to track them down. □

Max Paul Radloff lives in and braves the cool observing weather of South St. Paul, Minnesota. He is a musician by profession.

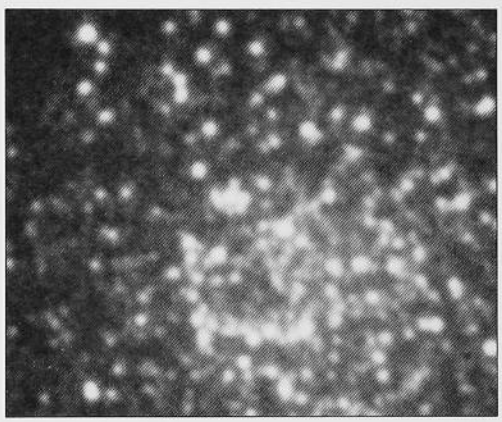
The Missing Lynx

Discover a neglected world of beautiful galaxies, challenging planetaries, and distant clusters.

by Phil Harrington

Tired of looking at the same old stuff night after night? Leave the brilliant stars of winter behind and scan northward. Occupying a rather barren tract of the late winter northern sky is the obscure constellation Lynx.

Most observers pass right by Lynx in favor of its more prominent neighbors Auriga, Gemini and Ursa Major. By doing so, they are ignoring some of the more unusual and unique objects of the season. Are you one of those observers who is missing Lynx? (Now, come on, you knew it was coming.) If you are, then there is no better time than right now to begin a survey of this celestial feline.



Take aim at the brilliant star Castor in adjacent Gemini, and swing your telescope 7° due north. Peering through a finderscope aimed in that vicinity, watch for a tight pair of 7th-magnitude stars. Once they are in view, switch to your telescope. If you are looking through at least an 8-inch instrument, you ought to notice a very faint blur just to the east of these two stars. That blur is **NGC 2419.** Nicknamed the "Intergalactic Tramp" by Harlow Shapley, NGC 2419 has long been famous as an extremely remote member of the Milky Way's family of globular clusters. Current estimates place it at about 90 kiloparsecs away, nearly three times the full span of the Milky Way itself. This cluster is believed to have a wide, eccentric orbit about our Galaxy.

NGC 2419 glows dimly at magnitude 10.4 and spans about 4'. Because none of its stars shine much brighter than 18th magnitude, NGC 2419 appears pretty much the same when viewed with any backyard telescope — faint and fuzzy, highlighted by a somewhat brighter core.

A number of faint galaxies are found within 5° of NGC 2419. The closest is **NGC 2424**, lying about 1° northeast of the cluster. A 12th-magnitude barred spiral, NGC 2424 is relatively easy to pinpoint thanks to a 7th-magnitude star just to the galaxy's southeast. Look for a long, thin, cigar-like disk punctuated by a subtle nucleus. Though usually reserved for 10-inch and larger telescopes, NGC 2424 may be visible in 8-inch instruments on exceptionally clear evenings.

Now travel back to NGC 2419 and drop southward toward Castor. About halfway along, you will pass a wide pair of 5th-magnitude stars labeled as 70 and 71 Geminorum. They both lie just south of the Lynx border and our next object: **NGC 2415.** Aiding in the quest for this faint, irregular galaxy is a 9th-magnitude field star just to its northeast. Actually, the star may be more of a hindrance than a help, because the starlight scatters enough to obliterate the galaxy's tiny magnitude 12.4 disk. Therefore, high power is suggested for the best view, to permit the galaxy's isolation from the star.

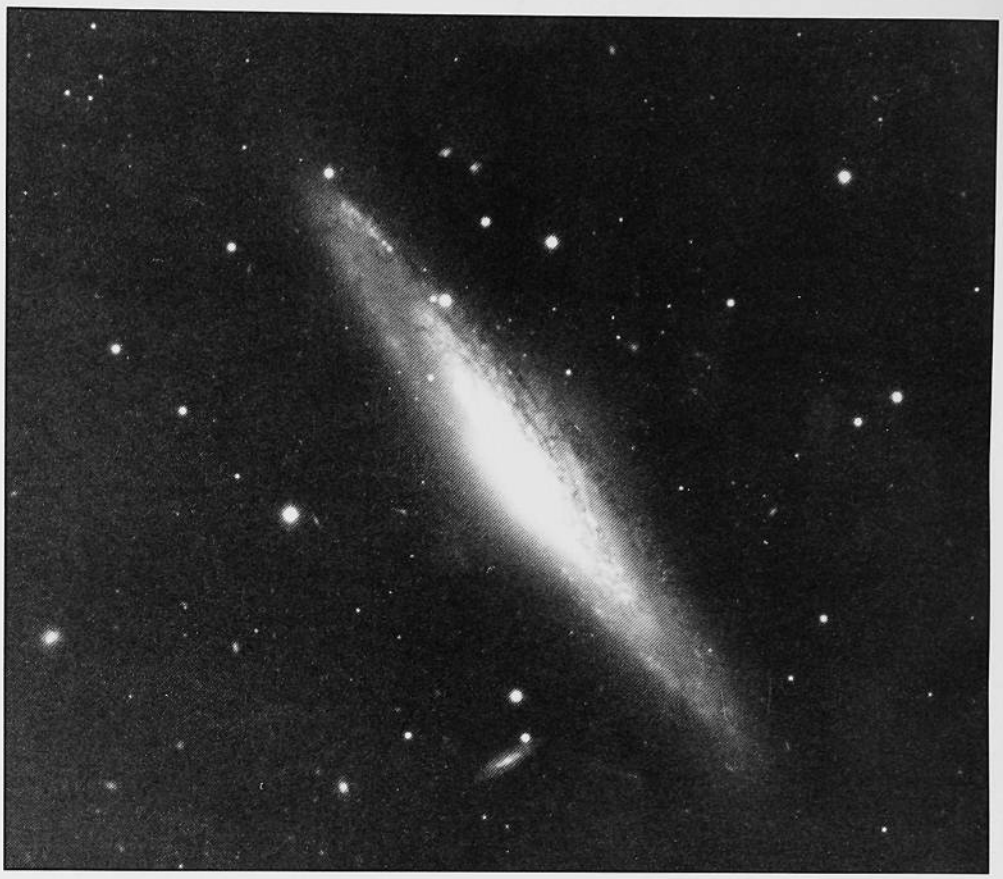
Scanning about 2° east of NGC 2419 will unveil the tight galactic team of **NGC 2444** and **NGC 2445.** Both galaxies seem to be physically linked to one another and surrounded by a distorted gaseous ring. Each shines at about 13th magnitude and spans 2' by 1'. Viewed with backyard telescopes, these galaxies appear as a collective single glow highlighted by two subtle nuclei. NGC 2444 is the northeastern member of the pair.

NGC 2476 is a faint galaxy about 2° northeast of NGC 2444 and NGC 2445. With a photographic magnitude of 13, this galaxy is not likely to be visible in instruments much smaller than 10-inchers. It is described by Dreyer in the *New General Catalogue* as simply a "very small star in an extremely faint, small nebula."

NGC 2493 and **NGC 2495** form a challenging pair of galaxies for backyard astronomers. The former, an SB0 galaxy, comes in at photographic magnitude 13.1 and covers 2.5'. The latter, found about 2' to the northeast, glows at only photographic magnitude 15.5! Can anyone glimpse both of these difficult sights?

NGC 2524 and **NGC 2528** form yet another faint galaxy duet. Separated by 11', each glows dimly at photographic magnitude 13. NGC 2528, the easternmost of the pair, appears as a small, round smudge through my 13.1-inch f/4.5 Newtonian at 150x, while NGC 2524 is equally tiny but even harder to confirm.

The remote globular NGC 2419 is a challenge for small telescopes. Official U.S. Navy photograph courtesy U.S. Naval Observatory, Flagstaff Station. Above: An extreme closeup shows the minute cloud of stars composing NGC 2419.



A professional observatory photograph of NGC 2683 shows the galaxy's delicate spiral arms and knotty dark lanes. Official U.S. Navy photograph courtesy U.S. Naval Observatory, Flagstaff station.

Three additional galaxies are widely scattered across the southwestern corner of Lynx. Of these, **NGC 2532** is the easiest to spot. Glowing at magnitude 12.4, this barred spiral subtends a little over 2' in photographs. Look for its tiny disk just southwest of two field stars. NGC 2532 may be just within the grasp of 8-inch instruments given clear, dark skies. About 2.5° northeast of NGC 2532 lies **NGC 2543**, a difficult barred spiral. The 2.5' disk rates only photographic magnitude 13, yet it can be spotted in 8-inch telescopes on exceptional evenings. The final galaxy in this area is **NGC 2484.** One of the unusual S0 transitional galaxies, NGC 2484 glows feebly at photographic magnitude 14.9. Only larger amateur telescopes stand much chance at nabbing its 1.6' by 1' disk.

NGC 2683 is the brightest galaxy in Lynx, and in fact, one of the brightest in the northern late-winter sky. Situated about 6° southwest of Alpha Lyncis and 2° northwest of Sigma^2 Cancri, this fine edge-on Sb spiral is clearly visible in giant binoculars and nearly all telescopes. An 8-inch scope reveals a sharply oval disk set off by a bright core, while larger apertures begin to unveil some subtle mottling to the galaxy's spiral halo. My 13.1-inch Newtonian at 150x hints at structure across the spiral-arm disk. While it appears to cover about 6' by 2' in backyard telescopes, the full photographic extent of NGC 2683 reaches 9.3' by 2.5'.

Third-magnitude Alpha Lyncis, found just inside the constellation's extreme southeastern border, acts as an excellent springboard to other galaxies in this part of Lynx as well. Less than 1° to the star's southwest lies a clump of no fewer than one dozen faint members of the *New General Catalogue*. All are crammed into a 0.5° area collectively catalogued as the galaxy group Abell 779.

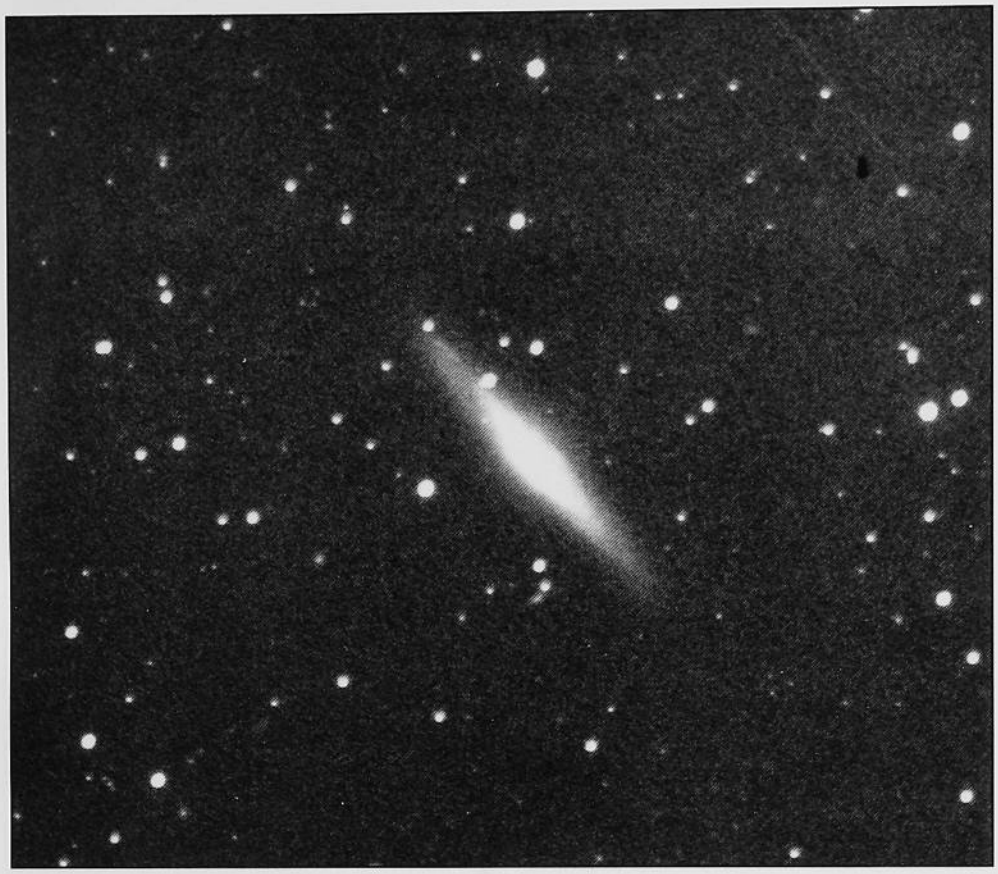
Brightest of the lot, at magnitude 11.5, is **NGC 2832.** Also known as Arp 315, NGC 2832 is apparent in telescopes 6-inches and larger. Years ago I spotted it through my 8-inch f/7 Newtonian as a "fairly large, considerably bright patch highlighted by a stellar nucleus." In photographs taken at professional observatories, the oval halo of this elliptical system spans 3.3' by 2.2', while it appears about half that size through backyard telescopes.

Just 0.4' south of NGC 2832 is **NGC 2831.** A 14th-magnitude E0 galaxy, NGC 2831 proves to be a difficult catch in even 12- to 14-inch instruments, perhaps because of the brighter glow from its nearby neighbor. With a miniscule diameter of only 0.8', NGC 2831 requires high power even to be discerned from the surrounding stars.

NGC 2793 lies close to both Alpha Lyncis and Abell 779, although it is not an actual member of the latter group. With a 12-inch or larger telescope, high power is needed to catch a glimpse of this 14th-magnitude Sc spiral. It will look like no more than a tiny, nearly stellar disk.

NGC 2840 lies about 1° north of Alpha Lyncis, and just southeast of a 10th-magnitude field star. Only the largest diameter backyard instruments hold much hope at revealing this galaxy's minute, 15th-magnitude disk, which was described by Dreyer in the *New General Catalogue* as "considerably faint, small, round."

A clump of three inconspicuous galaxies may be found about 2° northwest of Alpha Lyncis. The brightest of the lot is **NGC 2778**, although it only shines at 13th magnitude. An elliptical galaxy by nature, it measures 1.5' by 1.1' and lies just east of a 9th-magnitude star. To the southeast, but within the same medium-power eyepiece field, is **NGC 2780.** Appearing a full magnitude fainter than its neighbor, this tiny barred spiral has always eluded my searches. **NGC 2779** rests just 1.5' northeast of NGC 2778. At 15th magnitude, its



A high-quality backyard astrophoto shows NGC 2683 more closely as it appears in amateur instruments. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 65-minute exposure).

tiny disk is visible in 14-inch and larger telescopes.

About 30' north of the NGC 2778 gang is the easternmost member of a line of three 8th-magnitude stars. This is superposed on the western edge of an exceedingly faint galaxy, **UGC 4837.** Classified as an Sm system, UGC 4837 has a photographic magnitude of 14.4 and measures 2' by 1' across. Its apparent closeness to the dazzling field star makes it tough to spot. Amateurs with large-aperture telescopes will do best to switch to their highest-power eyepiece in order to isolate the galaxy from the star. It might be necessary to place some sort of occulting bar (such as a thin piece of metal) near the eyepiece focal plane to obscure the bright starlight.

Follow the line of 8th-magnitude stars to its western end, and then hop a bit further to a 9th-magnitude star. About 15' beyond this last star is **NGC 2746.** Don't expect to see much here: NGC 2746 glows dimly at 14th magnitude and appears as a small, round smudge with an ever-so-slightly brighter core. A 12th-magnitude star lies 50" north of the galaxy.

Just south of NGC 2746 is a trapezoidal pattern of four 8th- and 9th-magnitude stars. Set within this small area is **UGC 4777.** An irregular galaxy, UGC 4777 presents a 14th-magnitude, 2' by 0.4' cigar-shaped disk that is not likely to be visible in telescopes smaller than 16-inchers.

NGC 2719 and **NGC 2724** form an interesting pair of galaxies visible in large backyard telescopes. The former is actually a close set of interacting irregular galaxies also known collectively as Arp 202. Both shine dimly at photographic magnitude 13.7. NGC 2719 measures 1.3' by 0.4' in extent, and its companion, NGC 2719A, spans 0.6' by 0.5'. High magnification is normally required to resolve the pair. NGC 2724 is fainter still, at photographic magnitude 15. It appears stellar through nearly all backyard telescopes.

NGC 2638, **NGC 2649** and **NGC 2668** form a 2.5° triangle in the southern tier of Lynx. The brightest of these is NGC 2649, at photographic magnitude 13.1. This SBb barred spiral measures 2' across and shows a hint of central brightening when viewed through 12-inch and larger instruments. The other two galaxies successfully evaded my diligent search with a 13.1-inch scope in suburban skies. Perhaps readers with similar telescopes and rural skies will have better luck.

Skimming along the Lynx-Cancer border back toward Alpha Lyncis, we come to **NGC 2770**, a 12th-magnitude Sc spiral. Look for a faint, oval disk measuring about 3' by 1'. The largest amateur telescopes may also show **NGC 2770B**, which appears as an extremely faint, small fuzz just to the brighter galaxy's west. Still a little farther west lies **UGC 4787**, a wide-armed Sd spiral glowing dimly at 14th-magnitude. All three galaxies offer difficult challenges to observers.

Another clump of faint galaxies lies about 5° north of Alpha Lyncis. All are huddled within 2.5° of each other. The brightest of the lot is **NGC 2782**, a magnitude 11.5 Sb spiral. An 8-inch instrument records a fairly large, oval disk highlighted by a brighter starlike core. Amateur photographs show some subtle structure in the galaxy's halo; visual observers will likely see only a homogeneous glow.

Set just to the south of a pair of 8th-magnitude stars is **NGC 2844**. A 13th-magnitude Sa spiral, NGC 2844 is visible in 8-inchers as a soft, uniform patch of light.

The other galaxies in this region all require a least a 12-inch telescope for detection. **NGC 2852** and **NGC 2853** form a close-set pair of 14th-magnitude barred spirals in the same field as NGC 2844. Their separate identities can only be confirmed at high power. NGC 2852 is the southern and slightly brighter of the pair. Also nearby are **NGC 2785**, **NGC 2838**,

The NGC 2832 galaxy group offers a field full of faint fuzzies. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 60-minute exposure).

and **NGC 2860**, none of which shine brighter than photographic magnitude 14, and all of which challenge the largest amateur telescopes.

Several more galaxies are most easily found by starting at Kappa and Iota Ursae Majoris, marking the Bear's front paw. Moving to the southwest of Kappa about 2.5°, keep an eye peeled for a slim, triangular asterism of three 7th-magnitude stars. From the triangle's eastern tip, drop southward 1° to **NGC 2712**. NGC 2712 is a 12th magnitude object measuring 3' across. At 214x in my 13.1-inch reflector, the disk of NGC 2712 appears extended and brightens very slightly toward its center.

If you can spot NGC 2712, then the next galaxy will be visible in time — 13 minutes to be exact. With NGC 2712 in the field, turn off the clock drive, go inside, and warm up a bit. Return 13 minutes later, and Earth will have turned your telescope 3.25° east, targeting **NGC 2776**. Once there you should be able to glimpse NGC 2776 fairly easily through 8-inch scopes, as it glows at magnitude 11.6 and spans 3'. This round galaxy also has a stellar core that appears prominent when viewed with at least a 10-inch telescope.

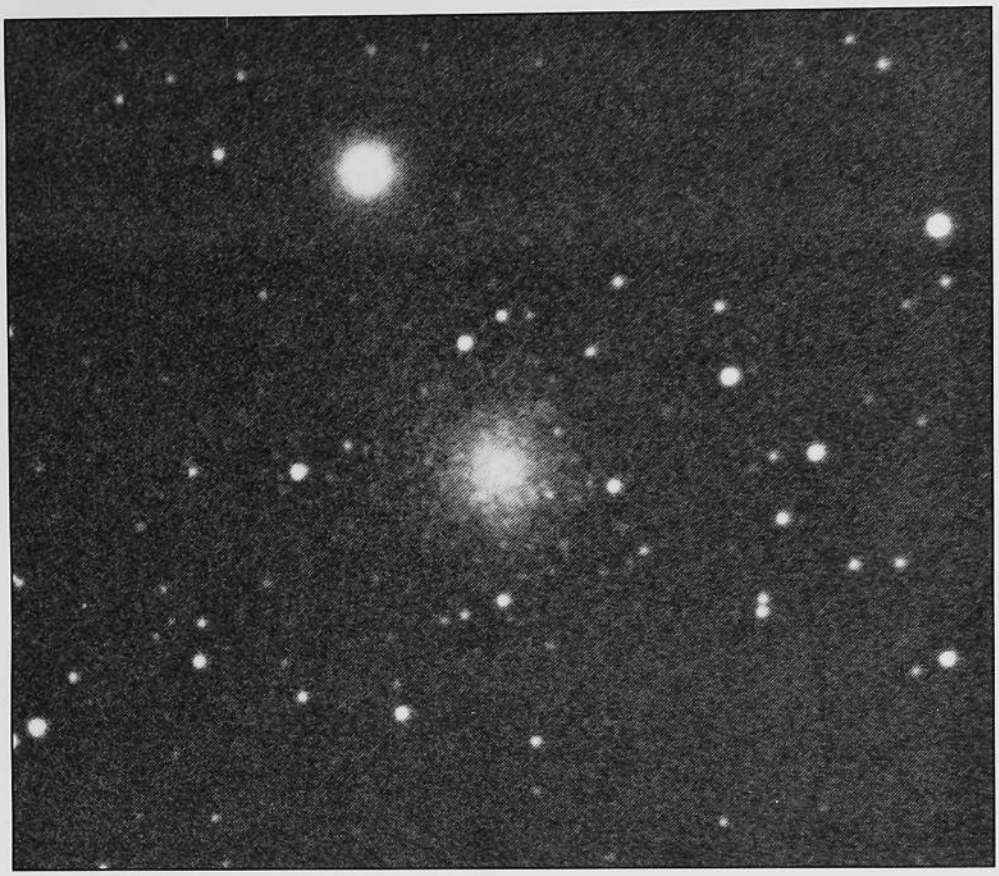
Next, draw a line from Kappa Ursae Majoris to 5th-magnitude 36 Lyncis, and extend it halfway again farther south of 36. Just west of a 9th-magnitude optical double in that spot lies **NGC 2798**, this region's brightest galaxy. A 12th-magnitude barred spiral, NGC 2798 impresses me as being shaped like a knockwurst. Try high power for the best view. Just to its southeast is **NGC 2799**. NGC 2799 glows dimly at 14th-magnitude and measures about 2' across. Its low surface brightness causes it to be missed in all but 16-inch and larger scopes. Scanning 2.5° west will show you **NGC 2755**. At 14th magnitude, NGC 2755 requires at least a 12-inch telescope to be seen.

Unlock those axes and slide westward from Iota and Kappa Ursae Majoris toward the wide double star 25 and 26 Lyncis. Now jog southeastward toward 31 Lyncis. Pause halfway between 25 and 26 and 31, near a line of three 7th-magnitude stars, and nudge your telescope just a bit northeast. Here you'll find **NGC 2537**, **NGC 2537A**, and **IC 2233**.

NGC 2537 is classified as a face-on Sb spiral, but with an unusual feature: a broken ring of bright nebulosity encircling its outer perimeter. At magnitude 11.7, the galaxy may be glimpsed through 6-inch telescopes, even through only moderately dark suburban skies. Its strange appearance is evident in 8- to 10-inch telescopes and is quite striking in larger instruments. Photographically this irregular ring displays many knots and remarkable detail. It gives the illusion of an animal's paw print, which has led NGC 2537 to be nicknamed the "Bear-Paw Galaxy." This title is especially appropriate given its close proximity to the front paw of Ursa Major. If you observe through at least a 16-inch telescope, then you might also notice a faint glow just east of NGC 2537. This is NGC 2537A, an exceedingly faint, wide-armed barred spiral. High magnification is necessary to detect its 0.7'-diameter disk.

Just south of NGC 2537, IC 2233 is somewhat easier to spot. IC 2233 is an edge-on SBd barred spiral notable for its extremely thin disk. While spanning 4.3' side-to-side, this galaxy measures a mere 0.6' wide, making it one of the thinnest galaxies visible in backyard scopes. At 13th magnitude, IC 23233 looks like a grayish sliver of light, with just a hint of a central bulge visible through 16-inch and larger apertures.

From 26 and 27 Lyncis, travel 6° northwest toward a parallelogram of 5th-magnitude stars that includes 20, 21, and 22 Lyncis. The star that marks the parallelogram's northeastern corner, 22 Lyncis, is a wide triple star. The primary shines at magnitude 5.4 and has a yellowish hue. The secon-



Martin Germano's photo of NGC 2419 approximates its appearance in a backyard telescope. Germano used an 8-inch f/10 SCT, 103a-F film, and a 75-minute exposure.

dary, a magnitude 10.2 speck, lies 170" away at p.a. 304°, while 22 Lyncis C glows dimly at magnitude 12.0 and is found 111" away at p.a. 150°.

If you continue 2.5° farther northwest, you will find yourself in the realm of seventeen faint galaxies. None exceed photographic magnitude 14, making a 10-inch the smallest aperture here. **NGC 2320** is the brightest galaxy in the area. Located just west of an 8th-magnitude field star, it appears as a small, slightly oval smudge of grayish light. Also in the same high-power eyepiece field as NGC 2320 are **NGC 2321** (12' north) and **NGC 2322** (6' south). Both are very small, with NGC 2322 outshining NGC 2321 by about a magnitude.

Half a degree west of NGC 2320 is the difficult pair **NGC 2326** and **NGC 2326A**. The former exhibits a relatively large, featureless disk just to the west of a faint field star. Its low surface brightness can make finding NGC 2326 a difficult task. Unfortunately, NGC 2326A is even tougher to pick out, and is only visible through the largest backyard scopes.

A quick glance at this general region on chart 42 of *Uranometria 2000.0* shows three galaxies south of NGC 2326. These are **NGC 2330**, **NGC 2332**, and **NGC 2340**. All are extremely dim and very hard to spot, but NGC 2340 is just a bit brighter than the others. What *Uranometria* fails to show are eight additional galaxies squeezed between NGC 2330 and NGC 2332, and NGC 2340. These unplotted systems include **NGC 2334** and **IC 458**, **IC 459**, **IC 460**, **IC 461**, **IC 462**, **IC 464**, and **IC 465**. All glow between photographic magnitude 15 and 16, and measure 1' or less in diameter. Can anyone see any of these challenging targets?

Of all the objects in Lynx, none has caused more controversy among deep-sky enthusiasts than **NGC 2474** and **NGC 2475**. Found about 2.5° northwest of 27 Lyncis, NGC 2474 is described in Dreyer's *New General Catalogue* as "faint, pretty small, extended?, brighter middle, very small star?, large star north following." NGC 2475 is simply noted as forming a double nebula with NGC 2474.

In 1939 astronomers at Harvard Observatory discovered a planetary nebula on patrol photographs that seemed to lie close to the original coordinates in the *New General Catalogue*. The nebula was a large ring-type cloud with two distinctly brighter east-west lobes. At the time astronomers assumed that these two nebulous clumps were the *NGC* entries, and so identified NGC 2474 and NGC 2475 as a single planetary nebula. They were wrong.

After more than four decades of confusion, astronomers determined that NGC 2474 and NGC 2475 are a close pair of elliptical galaxies southeast of a 9th-magnitude star (the "large star" in the *NGC* description). While their identity is now certain, there is still some discrepancy between the listed magnitudes of these two objects and their visual appearances. Although both are listed at photographic magnitude 14, NGC 2474 is just bright enough to be seen in 8-inch instruments, but NGC 2475 requires at least a 12-incher.

Lynx offers a wide range of challenging deep-sky objects for observers. Be forewarned, however, that to tame this cat successfully, you must go in with a large telescope, high-quality eyepieces, and a crystal clear night. Armed with these advantages, you will master the lynx. □

Phil Harrington is a regular contributor to Deep Sky *and* ASTRONOMY. *His book* Touring the Universe with Binoculars *was just published by John Wiley & Sons.*

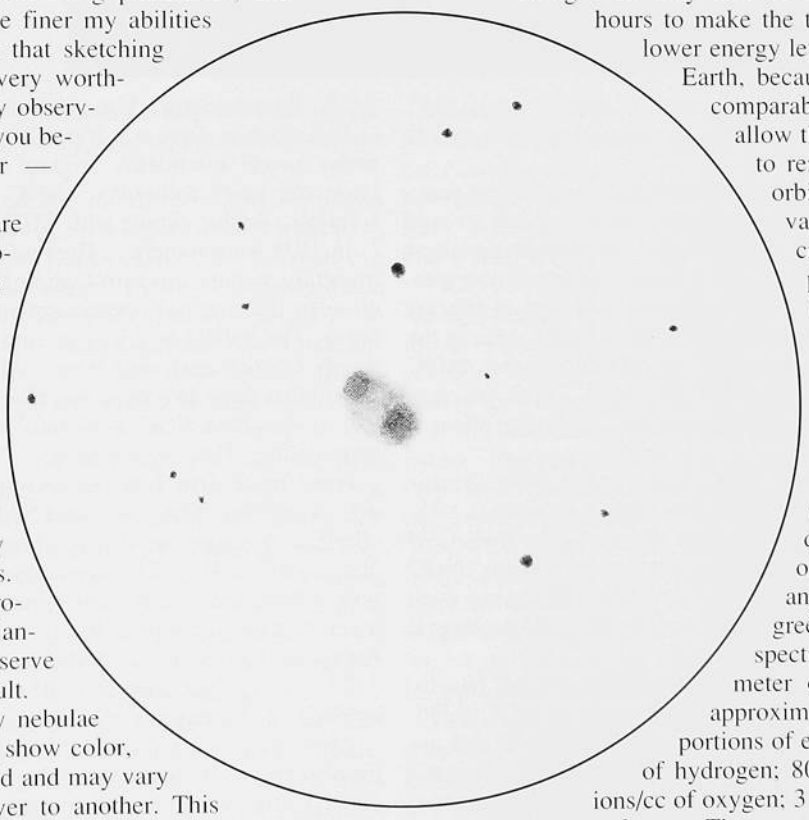
The Gentle Art of Drawing
Planetary Nebulae

Discover How to Capture an Exploded Star in Your Observing Notebook

by Larry Mitchell

I have been fascinated with planetary nebulae for several years now, and enjoy the unique challenges provided by observing them. During my past couple of years of observing I've discovered the rewarding pleasures of drawing, and have built up quite a collection of observations. I've found that I especially enjoy sketching planetaries, and that the more I do it the finer my abilities have become. I suggest that sketching planetary nebulae is a very worthwhile aspect of deep-sky observing, and that it can help you become a better observer — and it's fun, too!

Planetary nebulae are delightful objects to observe. These stars in their death throes come in all shapes and sizes. Most are elongated, but many are annular or square in shape and range in size from stellar to giants measuring several arcminutes in diameter with extremely low surface brightnesses. As with all types of astronomical objects, some planetaries are easy to observe and some are very difficult.



As a group, planetary nebulae are unusual in that they show color, which is often quite vivid and may vary in hue from one observer to another. This color is usually some variation of blue or green, and is due to oxygen III ionization. As free electrons recombine with ionized atoms, the negatively charged electrons follow their normal course and cascade down from a higher to a lower energy level as they attempt to get as close as possible to the positively charged protons in the atomic nuclei. As the electrons lose energy, they release photons of light at discrete wavelengths which we measure as different spectral emissions.

Normally, this transition occurs almost instantaneously, in something like 10^{-8} seconds, but in the nebulous cloud there exist states of ionization where the bond between the electron and proton is very weak. An electron that lands in such an orbiting shell may take several minutes to several hours to make the transitional jump to the lower energy level. This can't occur on Earth, because we cannot create a comparable vacuum which will allow the weakly-held electron to remain in the transitional orbit for so long. The best vacuum that mankind can create still has so many particles in it that this electron would be knocked off almost as soon as it lands in orbit, allowing no transition to occur. In space, we call such emissions "forbidden" and the strongest lines occur as double emission lines of oxygen at 4959 and 5007 angstroms in the blue-green area of the visible spectrum. Each cubic centimeter of the nebula contains approximately the following proportions of elements: 10,000 ions/cc of hydrogen; 800 ions/cc of helium; 6 ions/cc of oxygen; 3 ions/cc of nitrogen; and 1 ion/cc of neon. These numbers demonstrate how strong the oxygen emission is, although it should be noted that other atomic ionizations are also occurring which are not so strong nor easily detected by the human eye.

Planetary nebulae often show a definite structure with a subtle central brightening or one side having a brighter or clumpier appearance than another. Sometimes a layering effect or "ring within a ring" structure is visible. A good exam-

With its unusual series of rings, The Eskimo Nebula in Gemini is a fun object to sketch. The rendition above was made with the 36-inch f/7.5 telescope at McDonald Observatory at a magnification of 490x. Opposite page: NGC 2371/2, another Gemini planetary, sketched with a 10-inch f/10 SCT at 179x. All sketches in this article are by Larry Mitchell.

ple of this is NGC 6826, the Blinking Planetary in Cygnus. Sudden intense multiple outbursts in the core of the star are thought to cause this layering in the nebula's ionized halo.

It's often a challenge to see the central star in planetary nebulae. For some objects a central star has never been observed. This core or remnant of the original star radiates most of its light in the ultraviolet which is invisible to human eyes.

The age of the planetary and the surface brightness and opacity of the halo contribute to this difficulty. Also, in some planetaries, the central star is a binary, and in a few instances variable. NGC 2346 is a good example of a planetary with a central star that varies in brightness from magnitude 11.2 to 15. The central star in M57, the Ring Nebula, is thought to occasionally dim from its normal 15th magnitude to fainter than 16th.

Extended objects are difficult to see visually, having a very low surface brightness only slightly greater than the sky background. Most planetaries larger than 100" are extremely difficult visual objects, as are those smaller than 5", which appear indistinguishable from the background stars. Because planetaries radiate most of their light within a narrow region of the spectrum, LPR filters may help by increasing the contrast between the object and the sky background. It should be noted, however, that not all planetaries radiate strongly in wavelengths of light that will be easily passed by the filter. Also, some details such as the nebula's central star may be rendered impossible to see when using the filter.

I usually observe planetaries with and without a filter by

The largest planetary nebula in the sky, the Helical Nebula in Aquarius is difficult to capture on paper. This sketch was made with a 10-inch f/10 SCT at 78x, and records the nebula's smooth ring shape and dark central hole.

holding the filter in my hand and passing it back and forth over the eyepiece. This renders subtle detail visible that otherwise would be missed. This flickering technique is especially useful in locating very small objects that appear stellar in the eyepiece. The stars in the field will darken with the filter in place while the planetary remains essentially the same brightness with or without the filter. This effect at times can be quite stunning, and since most planetary nebula are very small in size, the technique is a useful observational tool.

Drawing is a very rewarding endeavor that can become habit forming. I've found that whenever I observe something I especially enjoy, I automatically reach for my drawing board. Many people can draw a smudge, and most people can draw a point, and this is all that is required. I do not consider myself an artist, yet I don't hesitate to make the effort. The most difficult part is proper placement of the stars, and this is merely a geometric procedure that simply takes practice to learn. It is very gratifying to "observe" my drawings the day after I make them and compare the detail to photographs, or compare them with drawings made on an earlier outing.

The only way to get a faithful rendition of the visual appearance of a planetary is to draw it. In photographs, it is often necessary to burn out the central region in order to get the outer halo on the photograph. This may eliminate the central star, or give it a prominence that is not seen visually. Before I begin a drawing, I spend some time studying an object. I often

Another unusually interesting planetary in Aquarius is NGC 7009, the Saturn Nebula. This sketch made with a 10-inch f/10 SCT at 278x shows the faint extensions that gave NGC 7009 its nickname.

use a hood over my head and face, and try different eyepieces and filters before I decide which magnification is best, and this is the field that I draw. I also closely observe the object for any subtle details and peculiariaties that I will draw later.

Sketching equipment includes a drawing board that opens up to hold my drawing pencils, papers, and accessories. I designed a drawing form to include space for descriptions of objects and sky conditions. Each form has two 3"-diameter circles. I also included a listing of eighteen questions that should be answered about the object's appearance. This comes in handy when the night gets long and it is easy to forget details. I use several drawing pencils of varying lead hardness and an artist's smudge pencil or stump, which I use to draw in nebular details. I've found this enables me to better regulate subtle brightness changes within the planetary halo.

When I am ready to draw, I try to make myself as comfortable as possible and sit down with the drawing board on my lap. A red LED seems to be the best source of illumination, although I find that an excessive amount of light is required in order to adequately see what I am drawing. This is why I spend time studying the object before I begin the drawing.

In drawing the field, I first draw in two or three of the brightest stars to facilitate positioning, and then begin drawing the planetary. It is usually best to start with the central region or star if present, and work out to the edge of the planetary, using the smudge pencil for the nebulous halo. Care must be taken with the size, as the natural tendency is to draw the object too large for the field. I always take plenty

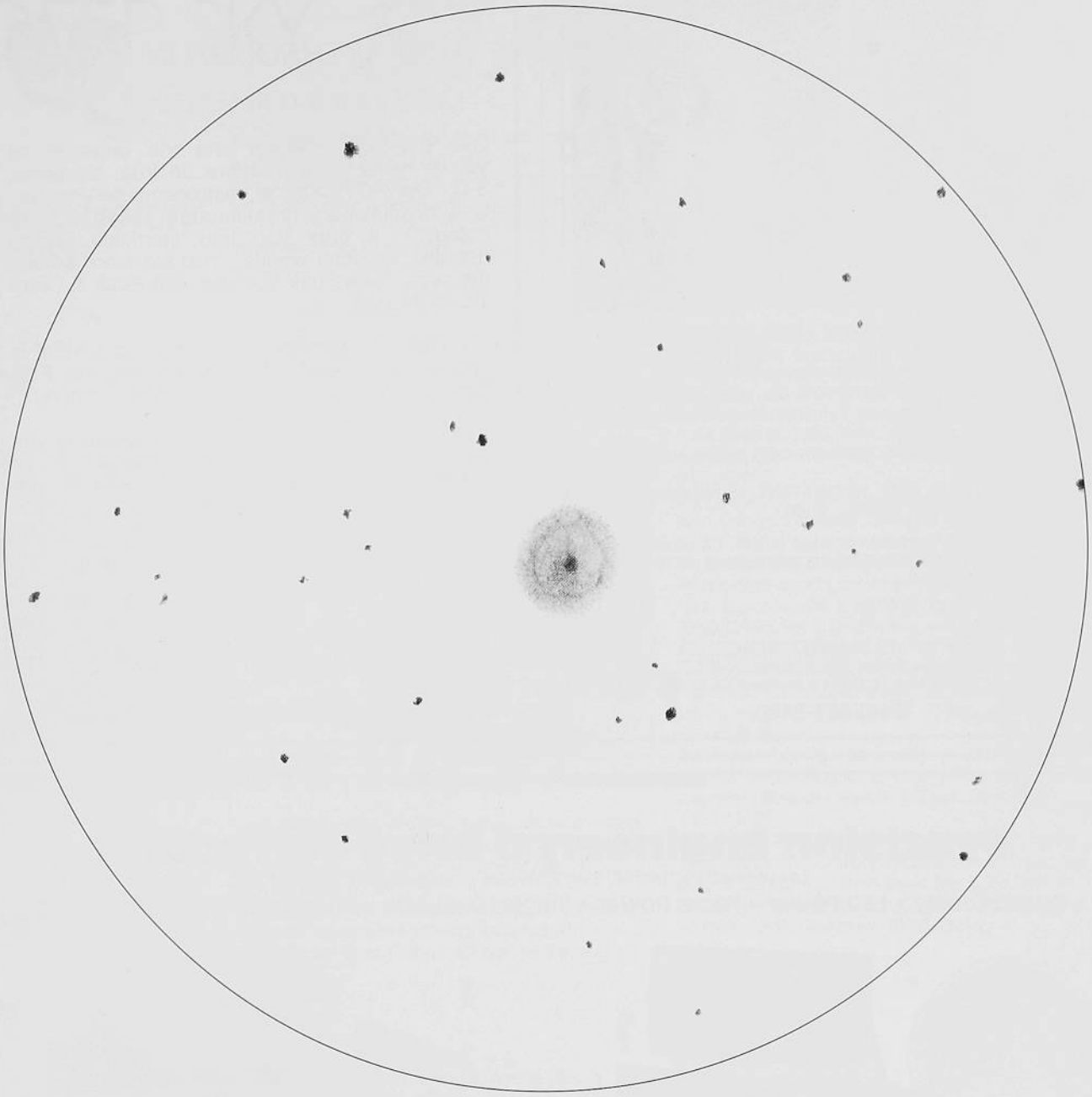
Although it is little-observed by backyard astronomers, ghostly IC 1470 in Cepheus is an attractive specimen for sketching. This view was made with a 10-inch f/10 SCT at high magnification.

of time with my drawings. Sometimes a drawing takes quite a while to complete. It may take several erasures, adding graphite, and smudge pencil sequences before it is right, and sometimes this requires a great deal of patience.

Once I have drawn the planetary nebula to my satisfaction, I then add in the faint field stars. I mentally divide up the field into four equal sections, and within each section I divide the distance from the edge of the planetary halo to the edge of the field. Then I draw in all of the stars that I can see within each section, noting any special geometric forms such as triangles, unusual angles, or asterisms to aid in proper positioning. The correct placement of these stars is very important, and any method for increasing accuracy should be employed.

Once the drawing is complete, I make a final overall comparison of the telescopic image and the drawing, making any necessary corrections to the drawing. Then I write down a complete description of the object and the field, along with sky conditions, the date, time, magnification used, and any other useful information. Sometimes this written procedure reveals detail that I missed during the drawing phase.

The next day, I review what was done the previous night. The light of day may reveal errors in the drawing that were not apparent the night before. It's best to do this review as soon after the drawing as possible while the telescope image is still fresh in your mind. I frequently make a duplicate drawing of the field, but this time I use a white charcoal drawing pencil and black poster paper cut into appropriate sized circles. The effect is very pleasing and often results in a



NGC 6826, the Blinking Planetary in Cygnus, is one of the most frequently observed planetaries. Yet capturing it on paper is not an easy task. This view was made with a 10-inch f/10 SCT at 282x, and shows the "ring within a ring" halo that surrounds the bright central star.

stunning rendition of the object.

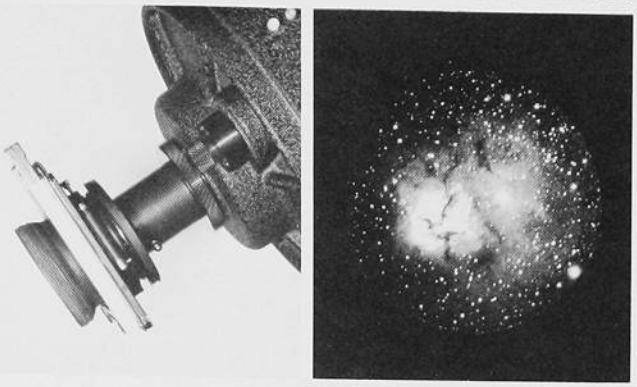
Once completed, drawings should be stored in as safe an environment as possible. I spray each drawing with special fixative spray coating that can be obtained in any art supply store. The drawing is then placed inside a clear plastic holder and inserted into a looseleaf binder with the objects in numerical sequence. It is very gratifying to have my own catalog of observations full of objects that appear as I saw them.

Another neat thing about sketching is that it improves your observing skills. While drawing, most people spend more time and look a little harder for some obscure detail that might otherwise not be noticed. The net result is that observational skills improve over time, and the best way to measure this progress is with a series of drawings. For example, the central stars in many planetary nebulae may not be drawn in the original observation, but are evident in later observations and drawings.

Planetary nebulae are beautiful objects to observe visually and fascinating objects to study. Drawing and keeping a record of these interesting objects is a very rewarding endeavor that can easily become addictive. Give it a try — you'll be glad you did. □

As if you couldn't tell, Larry Mitchell is an enthusiastic sketcher of planetary nebulae and is also well versed in other types of observing. He is an active member of the Houston Astronomical Society.

LARGE FORMAT ASTROPHOTOGRAPHY



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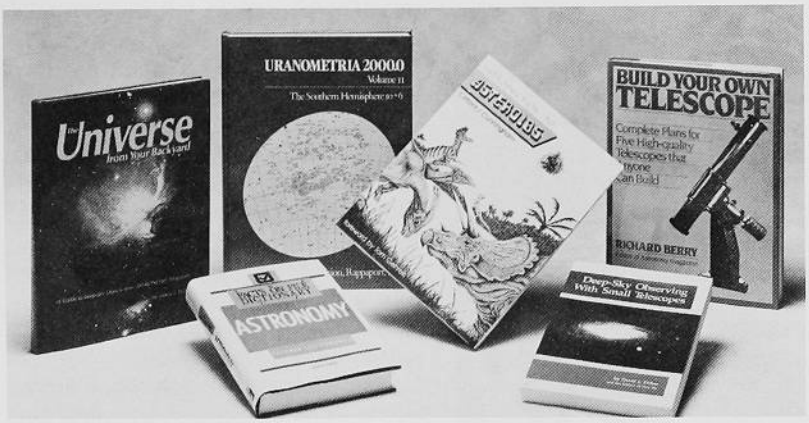

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Deep Sky Reports

Women Reach for the Stars at TSP

by Robert Reeves

Everyone attending the 1990 Texas Star Party knew this year's event would be better than last year's. Following the awesome lightning displays at the 1989 gathering, anything had to be an improvement. Although the sky this year was clear during part of each night, I soon came to realize this expectation of change was to be fulfilled in other ways.

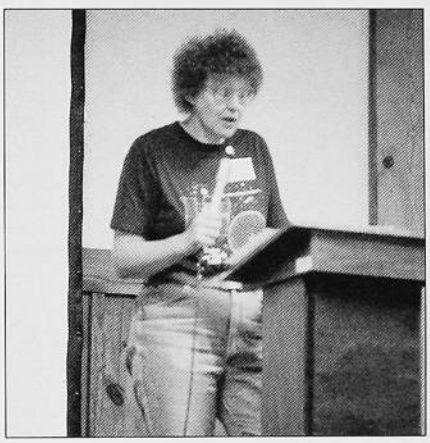
I arrived for the TSP at the Prude Ranch near Fort Davis, Texas, on Monday, the day before scheduled activities began. Already the observing field was packed with telescopes of every type and description, again setting a new world record for the most telescopes in use at one spot. The skies were also clear and sunny, a good sign that the following week of astronomical activity would delight everyone.

Soon, I spied a familiar friend, comet hunter David Levy. It was obvious that David was quite excited about something. His usual happy state had been upgraded to near exuberance. Let's face it — David now made a six-year-old child on Christmas morning look calm! I soon found out why as he told me he had discovered his sixth comet, Comet Levy (1990c), just two nights before. David related how after the discovery he drove to the Texas Star Party, arriving the next night. His first order of business was to go straight to Barbara Wilson's 20-inch Dobsonian to confirm the discovery.

As Monday's sunset darkened the observing field the friendly stars appeared. Two hundred telescope tubes turned upward without covers, looking like hungry baby birds awaiting their mother's feeding.

A special treat was in order for observers Monday evening, as Ron Dawes from San Antonio had predicted the *Hubble Space Telescope* would pass over the star party. He spotted the orbiting telescope shortly after it rose above the western horizon and mentioned it to me in an almost offhand manner. Realizing the high local interest in *HST*, I called out its position for all to see. That was like dropping a stone into a pond as ripples of excited yells quickly passed across the observing field. Everyone cheered as the *HST* reached first magnitude and passed near Spica high in the southern sky.

Later in the evening as I cruised around the ranch greeting my old TSP friends, I sensed something different about the Star Party this year. Then I realized it was the women! There were families, wives, girlfriends, and single women there in force. What's more, the women also had some of the largest telescopes!



Kathy Machin won this year's Lone Stargazer award. Photo by Ed Flaspoehler.

Then it dawned on me — the Texas Star Party had undergone a quiet revolution and achieved a new level of maturity. The TSP was no longer a male-dominated gathering. A large number of active women astronomers and observers had slowly changed the atmosphere of the event over the past several years. Of the 650 star seekers gathered under the west Texas skies, one third were women. As I walked through the forest of telescopes, it was not unusual to see male and female observing teams, one at the eyepiece, the other with star chart in hand anxiously waiting their turn.

I couldn't resist finding out what drew these women to astronomy and out into the Texas desert to a convention which until very recently consist almost entirely of men. Abandoning my own telescope, I spent the evening talking to the women astronomers at TSP.

I learned that happy childhood experience with astronomy encouraged many of these women to pursue the sky. Amy White, president of the St. Louis Astronomical Association, remembers, "When I was a child, my grandfather used to tell me constellation lore. He had a three-inch refractor I used to look at the Moon."

Astronomical League treasurer Debbie Moran from Houston relates, "My father is the one who got me interested in astronomy. He used an orange light bulb to demonstrate the phases of the Moon."

Tracy Weber, an astrophysics and computer sciences major from Dallas, recalls, "When I was 11, my Mom got a subscription to ASTRONOMY Magazine and it piqued my interest. She read to me about the Greek legends, and then I found out those legends were based on the stars!"

Tracy also related her early sky watching by adding, "When I was a young girl, I went horseback riding in the country at night. Knowing the constellations, I could find my way home. I had an older gelding I could get up on without a bridle out in the pasture. He would graze while I lay on his back and watched meteor showers."

Others began their love affair with the sky later in life. Mary McGauly, a surgical nurse from San Antonio, Texas, credits Robert Scheppler of McDonald Observatory with bringing her into the fold. "He was the one who gave me my first view through a telescope," says McGauly. "He showed me Halley while it was still a fuzzball. I looked through the eyepiece and thought I had died and gone to heaven!"

Astronomy has also had a positive effect on the family life of many of the women at the Texas Star Party. Paula Drake, a registered nurse from Houston, proudly states, "Astronomy is what drew my husband and I together before we were married. I was at the 1987 TSP with my daughter while Kenneth was here with the Houston Astronomi-

cal Society, and we gravitated together. I began astronomy on my own, but having Kenneth as my husband now keeps my interest up because we enjoy observing together."

Kathy Machin, Astronomical League awards chairperson from Kansas City, recalls, "I met my husband, Gil, at an astronomy club meeting. On our first date, he found me my first telescope, a 5-inch Apogee scope. It used to be that Gil would build telescopes and I would use them, but now I have gotten him more interested in observing."

The ladies attending the TSP this year were not content just to look through other people's telescopes. They brought their own, ranging from the unusual to the gigantic.

Amy White is a grade school teacher who uses her 4-inch Dobsonian at children's star parties. "I ground the mirror myself," says White. "I am so proud of it! The rocker box is painted pink and the bottom bearing is the 'Pink Cadillac' LP by Bruce Springsteen. The tube is wrapped with beige-colored shelf paper covered with little cats in dresses. You can tell its owner is a domestic goddess — and it's a fine ice-breaker at star parties."

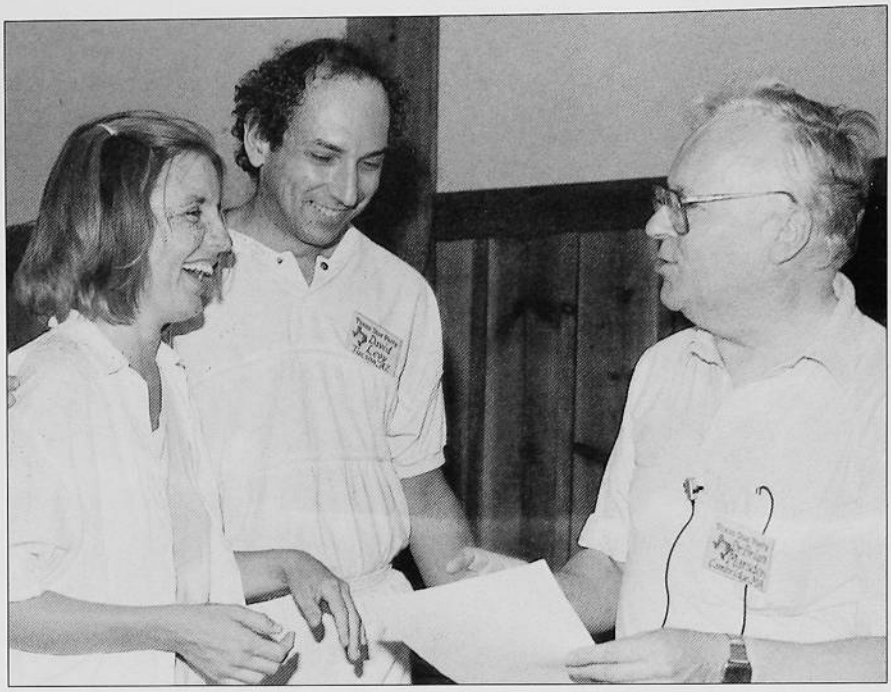
White is also building a 10-inch telescope with her newly-arrived Coulter mirror. She is looking forward to "learning how to measure variable stars; I think I would find that very satisfying."

ATM activities also exist in the Machin household. "Of the telescopes Gil and I build together," says Kathy, "the 18.5-incher is more like our telescope, while the 16-incher is more like his. In the future, we will grind a 12.5-inch f/5.6 mirror that will be used in my telescope."

Houston's Barbara Wilson and Paula Drake, who are close friends, own two of the largest telescopes at the Texas Star Party. Barbara's 20-inch Dobsonian has made three trips to the Prude Ranch. Paula's 24-incher saw first light at this year's TSP.

After the 1988 TSP, Paula decided she wanted a larger telescope than her 13-inch Dobsonian. "I called Paul Jones in Flagstaff and asked him to make me a 24-inch f/5.6 mirror," says Drake. "Three months later it was ready. We got to watch as it went into final polishing. It was like watching our baby being born."

Although the ladies of the TSP have achieved success and acceptance in the hardcore amateur community, they agree this was not always the case. Until now, equality with many highly competitive men has been an uphill battle. "Men have finally realized that we are here to do serious astronomy," says Drake. "Also, women who are married to amateur astronomers are beginning to realize the men are not going to give it up and are getting into it themselves so they can be with their husbands."



Debbie Byrd receives an asteroid citation from Brian Marsden, and David H. Levy gets into the act, too. Photo by Robert Reeves.

"It's a mystery to me why there are not more women interested in astronomy," says Wilson. "The universe is so beautiful and unboring, and women appreciate beauty." Moran adds, "I think astronomy's appeal to most people is aesthetic as well as scientific. I think that is something women can enjoy."

In defense of astronomy in general, Weber thinks "in astronomy we shouldn't think men or women. It's the love of the stars that pulls us together. That's what we should concentrate on."

So women and men together lived through another TSP. Star party activities kicked off Tuesday afternoon with an astrocomputing seminar that was established by Robert Reeves, Ron Dawes, and Gary Dowdel. The seminar included a CompuServe forum and demonstrations of astronomy software.

Interest in astrophotography remained high this year. On Wednesday Tony Hallas unveiled his most recent experiments with Fujichrome Super HG 400 and received a standing ovation — the results were outstanding.

One of the worst kept secrets of this year's event was announced officially during Brian Marsden's keynote speech. Marsden told the crowd that Debbie Byrd, originator of the Texas Star Party and columnist for ASTRONOMY, would have an asteroid named in her honor.

Saturday night's featured speaker was none other than Walter Scott Houston, dean of deep-sky observers. Scotty's theme was the evolution of test objects for telescopes. He concluded that there are no permanent test objects because amateur observers and instruments are continuously improving and conquering all the difficult objects.

In the concluding ceremonies, Houston received the prized Omega Centauri award for his many years in amateur astronomy. The other major award, the Lone Stargazer, went to Kathy Machin for contributions to visual observing.

The next morning the whole show packed up and drove off, a little better because of the experience. As Mary McGauly told me, "Where else can you get together with 650 people and share a common interest — and some of the people are even men." □

Robert Reeves is a freelance writer living in San Antonio, Texas. He has frequently contributed to Deep Sky *and* ASTRONOMY.

Deep Sky Reports

NGC 7129 and NGC 7133: An Identity Crisis

by Gordon Bond

Have you ever heard of a galaxy that is in all the catalogs but doesn't exist? A group of galaxies with no certain identifications? Welcome to the world of the astrodetective!

A little mystery of my own caused me to venture into this world recently. Once I immersed myself in the problem, I sought the help of two of its leading researchers. What you are about to read is a true story. No names have been changed to protect anybody!

Most of these mixups happen with galaxies, and usually only with those that glow dimly at about 15th magnitude. In the heart of Cepheus, however, I uncovered a mystery involving two nebulae and an open cluster, which may or may not be a cluster.

It all began on the night of September 15, 1988, when I first observed what is plotted on Tirion's *Sky Atlas 2000.0* as two nebulae in Cepheus, NGC 7129 and NGC 7133. The only thing I was able to find was a small group of seven stars in nebulosity. The object seemed to have bright parts surrounding stars, which I initially thought might explain the two *NGC* designations. *Burnham's Celestial Handbook* listed both as nebulae, NGC 7133 being a small, detached piece of NGC 7129. I made a drawing of the object and moved on.

When I purchased my copy of *Uranometria 2000.0*, Volume I, NGC 7129 was plotted as an open cluster. Not only that, but *Sky Atlas* plotted NGC 7133 as the northernmost of the two. *Uranomet-ria* shows NGC 7129 as the northern- most. Clearly something was wrong. I spent an afternoon going through all the catalogs I owned in search of the answer. By nightfall I was even more confused.

I suspected that NGC 7129 and NGC 7133 might be a single nebula involved with a cluster. Which designation went with which object, however? The listing from *Sky Catalogue* was the most confusing. It lists NGCs 7129 and 7133 as two nebulae at the same position, while it lists NGC 7129 alone as an open cluster. *Sky Catalogue* places the combined object as the northernmost.

Because I was getting nowhere fast, I decided to obtain the opinions of two amateurs who are experienced with solving such problems, California's Steve Gottlieb and Malcolm Thomson, who lives in Mexico. Each has written extensively on various errors in the catalogs.

Steve Gottlieb responded to an inquiry with his own observations and a copy of the *Catalogue Pages* published by the National Deep Sky Observers Society, which contained further observations of the area. While both Gottlieb and Thomson observed NGC 7129 as a cluster with nebulosity, NDSOS observer Jenny Worsnopp saw it as a cluster. Gottlieb is quick to point out, however, that he wouldn't glorify NGC 7129 by calling it a cluster.

Thomson provided a history of confusion between the two objects that ultimately led to the mystery's answer. NGC 7129 was discovered by William Herschel and later confirmed hy John Herschel. Both Herschels apparently described it as a nebula containing three stars.

The French astronomer M. G. Bigourdan observed NGC 7129 and added a second object which he placed 172" north and 84" west of NGC 7129. So far so good. Dreyer gave a separation between NGC 7129 and NGC 7133 of 234" in declination and 85" in right ascension. Still safe.

The *RNGC*, however, provides a separation for 7129 of 180" south, contra-

NGC 7129 and NGC 7133: The Confusion Game

NGC 7129

Source	Type	R.A.(2000.0)	Dec.	
Sky Atlas 2000.0	Nebula			
Uranometria 2000.0	Cluster			
Burnham's	Nebula	21h42.0m	+65°52'	
Webb Society 2	Nebula	21h42.6m	+65°59'	
Webb Society 3	Cluster	21h42.6m	+65°59'	
Sky Catalogue	Nebula	21h44.4m	+65°10'	
Sky Catalogue	Cluster	21h41.3m	+66°06'	(NGC 7129/33)

NGC 7133

Sky Atlas 2000.0	Nebula			
Uranometria 2000.0	Nebula			
Burnham's	Nebula	21h43.4m	+65°10'	
Sky Catalogue	Nebula	21h44.4m	+65°10'	

Webb Society 2 = Volume 2 of the *Webb Society Deep Sky Observer's Handbook*; Webb Society 3 = Volume 3 of the same work.

Amateur Observations of NGC 7129/NGC 7133

Source	NGC 7129	NGC 7133
Gottlieb	Nebula/cluster	—
Worsnopp	Cluster	Nebula
Thomson	Nebula/cluster	Nebula

Closely related and sometimes confused, nebulae NGC 7129 and NGC 7133 appear in this image. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 40-minute exposure).

dicting not only Bigourdan and Dreyer, but also itself! The *RNGC* rectangular coordinates make it 198" north. Rectangular coordinates were taken from the *Palomar Observatory Sky Survey* plates.

Thomson examined the appropriate Palomar print and drew the following conclusions: "[the plate] clearly shows the major nebula that contains stars is [NGC] 7129 and, in my opinion, the number of associated stars would not justify it being described as a cluster."

He found Bigourdan's NGC 7133 to be a fainter nebula. It lies very close to the position given by Bigourdan.

From the evidence presented here, I have made the following conclusions. NGC 7129 is the southernmost of two nebulae that may be connected. It is the nebula I observed as nebulosity around seven stars. The reason it is listed as both nebula and open cluster is that while there is definitely nebulosity associated with several stars, it depends upon the criteria of the cataloger as to what constitutes a cluster. Jenny Worsnopp's ohservation may have been due to the local seeing, so that only the associated stars were visible.

The confusion as to which object is northernmost apparently stems from an error in the *RNGC*. Thomson's examination of the Palomar plates showed NGC 7133 north of NGC 7129. This agrees with the observations of Bigourdan and Dreyer.

If these conclusions are accepted, the following corrections should be made. *Uranometria*'s chart 33 should be corrected to show NGC 7133 as the northernmost object. The class of NGC 7129 is open to interpretation.

Sky Catalogue 2000.0 should also be amended. Visually, NGC 7129 and NGC 7133 are two separate objects, and this should be reflected in the listings (just as M42 and M43 are separate listings in spite of being part of the same complex.). Lastly, the *RNGC* should also be corrected, as it was the source of informaticn which may have led others to the wrong conclusions. Case closed! □

Gordon Bond is the editor of The Practical Observer, *a newsletter for amateur astronomers. He lives in Middlesex, New Jersey.*

Deep Sky Reports

Exploring the Lacerta Milky Way

by Jerry Spevak

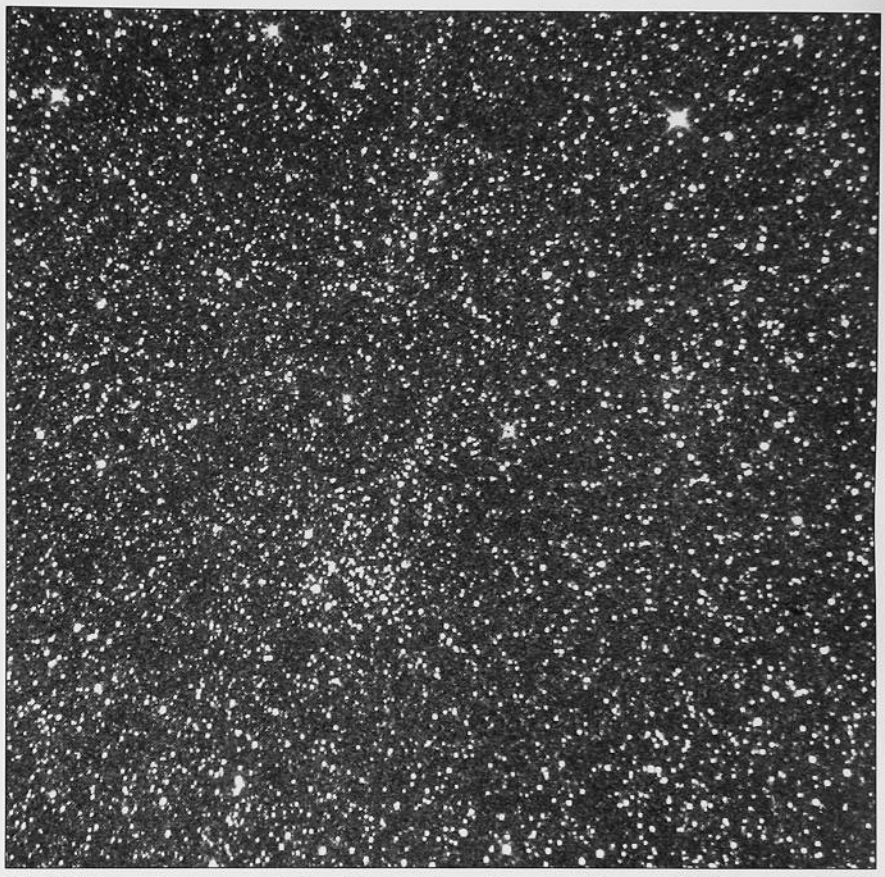
Lacerta is a rather obscure little region and is often bypassed by celestial explorers in favor of nearby Cygnus or Cassiopeia. Though not as large or richly endowed, Lacerta contains treasures both subtle and beautiful. The southern portions are relatively barren (though certainly worth exploring), containing only faint galaxies, but to the north the celestial lizard dips its head into the rich Milky Way. Here, fields are star-studded, clusters and nebulae abound. Once visited, this oasis always beckons a return.

Last autumn I had the opportunity to explore this region with the North York Astronomical Association's excellent 12.5-inch Newtonian reflector. Although this instrument is housed only a short distance from Toronto, on this particular night the sky was unusually transparent and the glow of the city was barely perceptible. The seeing proved to be first rate and at high power stars of magnitude 15.5 could be glimpsed near the zenith. Because of its far northern declination, Lacerta culminates rather high even for Canadians, and I was able to push the telescope quite deep.

Our tour begins with **NGC 7209**. This bright open cluster is about 20' in diameter and has a distinctly triangular shape. With the 12.5- incher, about 75 stars 8th-magnitude and fainter are visible. A 9th-magnitude orange star lies near the center of the cluster. NGC 7209 is not rich and is most impressive at lower powers.

PK 100-8.1 is a nearly stellar planetary nebula of about 12th magnitude. It appears only slightly extended, like a star that's fuzzy around the edges. Use the highest power that you find practical on this object. A UHC or O III filter greatly enhances this planetary, making identification fairly straightforward.

NGC 7243 is a very impressive open star cluster. About a half degree in size, it contains perhaps one hundred stars from 9th to 15th magnitude. A dark lane runs down the middle of the cluster, splitting it in half. Near the center lies a very nice bluish double star.



IC 1434 is a cluster containing 50 stars in a diameter of some 15'. Photo by Lee C. Coombs (10-inch f/5 reflector, 103a-O film, 10-minute exposure).

IC 5217 is an 11th-magnitude planetary nebula. To me it appears stellar, but larger scopes and more experienced observers may be able to make out a disk. As with PK 100-8.1, UHC and O III filters do wonders here. With the filter in place, the nebula stands out quite well in the crowded star field. Just a few minutes north-preceding IC 5217 lies **Kwai's Crescent.** This is a bright curving star chain made up of 9th- to 13th-magnitude stars. There are ten stars in all, and the chain extends some 15' across.

IC 1434 contains approximately fifty stars, the brightest of which glow at 10th magnitude. It's 15' in diameter and has a unique, irregular shape. Two star chains extend out to the east and two extend to the west. The southern portion contains a lovely trapezium of 10th-magnitude stars.

IC 1442 is a fairly prominent cluster containing close to fifty stars. They range in brightness from 9th to 15th magnitude. Within the cluster are two orange stars — one in the north and one in the south. IC 1442 is about 8' across and has a squarish outline. In addition, the western part appears more concentrated.

NGC 7245 is quite faint but fairly rich. This cluster contains some fifty stars between 12th and 15th magnitude. A lone 10th-magnitude star lies in the south-preceding quadrant. Overall, the cluster is four by five minutes in size and is extended in position angle 110°. Its outline is irregular, and several dark lanes are evident.

Far left: NGC 7243 is a scattering of 100 stars over 30'. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 30-minute exposure.
Above: NGC 7245 is an attractive sight in small scopes and is noted for its richness. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 70-minute exposure).
Left: NGC 7209 is distinctly triangular and spans 20'. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 30-minute exposure.

King 9 is an even fainter cluster just north of NGC 7245. It's visible as a faint glow with a sprinkling of four or five 15th-magnitude stars. This challenging cluster is about 11.5' in diameter and has a somewhat irregular, patchy outline in the 12.5-inch scope. Use a wide range of magnifications on this object.

PK 102-2.1 is otherwise known as Abell 79. Abell planetaries are usually quite extended and this one is no exception, being close to one full arcminute in diameter. It appears brighter in the center and is poorly defined near the edge. The outline is essentially circular. I found Abell 79 extremely difficult, as I could barely hold it with averted vision. UHC, O III, and Hα filters do very little to improve contrast here.

Berkeley 96 is a moderately bright cluster containing a dozen stars, 10th magnitude and fainter. A bright central star dominates the field. The cluster is 2' in diameter.

PK 104-1.1 is also catalogued as Minkowski 2-53. This faint planetary is about 15" in diameter. Its disk has a fairly even brightness and a circular outline. Its edge is moderately well defined. A 14th-magnitude star lies near its southern edge — a very pretty sight. I found that a broad band filter worked well, improving contrast noticeably.

NGC 7295 is classified as nonexistent in the *RNGC*, yet it's readily identified on the Palomar *Sky Survey* and at the eyepiece. It's located inside a triangle of 8th- and 9th-magnitude stars. Since none of its members are brighter than 13th magnitude, high powers are needed to bring this cluster alive. About a dozen stars are splashed across 2' of sky. The cluster is slightly elongated in the east-west direction.

NGC 7296 is a moderately rich open cluster containing twenty-five stars from 11th to 15th magnitude. It measures 3' by 5', and its trapezoidal outline extends in a position angle of 110°. A bright orange star lies at its preceding edge.

Berkeley 98 is another sparse star cluster, containing some twenty stars 10th magnitude and fainter. The cluster measures 3' by 5' and is elongated in position angle 30°. The southern portion is a little bit more condensed.

Just a few minutes north of Berkeley 98 lies an asterism I call **The Smile.** This asterism contains a curving chain of eight 11th- and 12th-magnitude stars. Together with a couple of nearby stars, the group looks like a face — use your imagination!

NGC 7394 is another so-called nonexistent cluster. It contains over a dozen stars 10th magnitude and fainter. The cluster is 5' by 8' in size and is extended in position angle 170°. An 8th-magnitude star lies at its southern edge.

PK 104-6.1 or Minkowski 2-54 is a 12th-magnitude stellar planetary. It does not respond well to filters, and I could only identify it by using the finder chart in the *Catalogue of Galactic Planetary Nebulae.*

Although a 12.5-inch scope was used to make these observations, a much smaller instrument could do as well under dark skies. The possibilities for larger scopes are incredible. □

Jerry Spevak is an enthusiastic observer living in Willowdale, Ontario, Canada.

Deep Sky Reports

Reader's Page

by Steve Coe

Response to *Reader's Page* has been nearly overwhelming, and we want to thank all readers who have sent observations. We will endeavor to publish as many of them from as many different observers as we can, and observations not used in this column are fair game for future articles. So keep those observations coming!

AURIGA

Tom Polakis, Tempe, Arizona: I used a 13.1-inch f/4.5 reflector for all of the observations. I would like to share what I recorded with readers.

NGC 1664: At 115x this open cluster contains about 30 stars of 10th and 11th magnitude in a rich star field. The cluster contains a prominent chain of ten stars trailing southward to an 8th-magnitude star.

NGC 1907: At 115x thirty 11th-magnitude stars in a very condensed field constitute this small group that stands out well from the Milky Way. The cluster is round and resolves easily. Very nearby to the north lies M38. Backing off to 75x, NGC 1907 and M38 form a pair similar to the more celebrated M35/NGC 2158 association in Gemini.

NGC 1893: At 115x fifty stars of 10th to 13th magnitude make up this very compact, round group. The faint nebula IC 410 is involved with the cluster.

IC 410: This is a very complex region of nebulosity. With an O III filter at 62x, a C-shaped glow is prominent, filling half the 1° field. There are many faint notches in the nebulosity and an extended faint region to the east.

Colin Russell, Crawley, Sussex, England: I made all of my observations with a 9-inch f/6 reflector.

NGC 1857: At 104x this is a small, fairly regular cluster, about 6' in diameter, with a 7th-magnitude orange star near its center. About 20 stars comprise this cluster down to 11th or 12th magnitude.

NGC 1907: At 104x this is a small, regular cluster about 7' across, with a number of 11th-magnitude stars and an unresolved haze surrounding the group. This object lies in the same low-power field as M38.

Dennis E. Hoverter, Mechanicsburg, Pennsylvania: I used my own 8-inch f/4.5 reflector at 90x for most of my observations.

NGC 1664: I observed 25 stars in this group and noticed an overall irregular appearance. A faint nebulous glow was visible between some of the stars, undoubtedly representing unresolved light from faint stars.

NGC 1857: I observed 30 stars radiating outward from the bright central star like a loosely structured pinwheel.

NGC 1907: I observed a somewhat bright, compact open cluster. It seemed more like a loose globular cluster that might have been nicely resolved with a larger telescope.

Steve Coe, Glendale, Arizona: I observed all of the Auriga objects with a 13-inch f/5.6 reflector.

NGC 1664: This cluster appeared pretty bright, pretty large, not very rich, and uncompressed. I counted 30 stars at 135x. An 8th-magnitude star lies on the south side of the cluster, and a nice little chain of stars leads over to it.

NGC 1857: This group is bright and rich. It is quite attractive at 165x, with an 8th-magnitude yellow star near the center. Several lines of stars radiate outward from this point. I counted 45 members within a diameter of about 12'.

NGC 1893: This object is bright, pretty large, and uncompressed. I counted 61 stars in the cluster.

IC 410: Without a UHC filter this object is faint, large, and irregular. With the UHC the nebula appears pretty bright and is clearly seen at 100x. The nebula surrounds the open cluster NGC 1893.

NGC 1907: This cluster is pretty bright, pretty small, much compressed and resolved at 165x. It is just visible in an 11x80 finderscope, and I counted 22 stars in the telescope.

IC 2149: This object is pretty bright, small, and a little elongated. The central star comes and goes with the seeing at 270x. The planetary appears as a greenish blob elongated 1.5:1 in an east-west orientation.

Auriga contains many other unusual objects, but let's now go back and include some observations of Lyra and Pegasus we couldn't fit in the last issue.

LYRA

Gordon Bond, Middlesex, New Jersey: I have used a 10.1-inch f/4.5 reflector for my observations.

M56: This globular appears as a small, amorphous glow at 43x. At moderate powers I could achieve some resolution, giving it a grainy apearance.

NGC 6765: At 96x this planetary is visible only with an O III filter. It appeared elongated north-northwest to south-southeast, and was very faint and difficult to hold with direct vision. I suspected some mottling, but could not be sure.

PK 64+15.1: This tiny planetary appears stellar at low powers. At 192x I suspected a slight elongation, though it was indistinctly visible due to periods of turbulent seeing. I've read that this elongation may be due to a 13th- or 14th-magnitude star almost in contact with the disk.

PEGASUS

Dan Lazar, Calgary, Alberta, Canada: I use a 13.1-inch f/4.5 reflector for all of my observations.

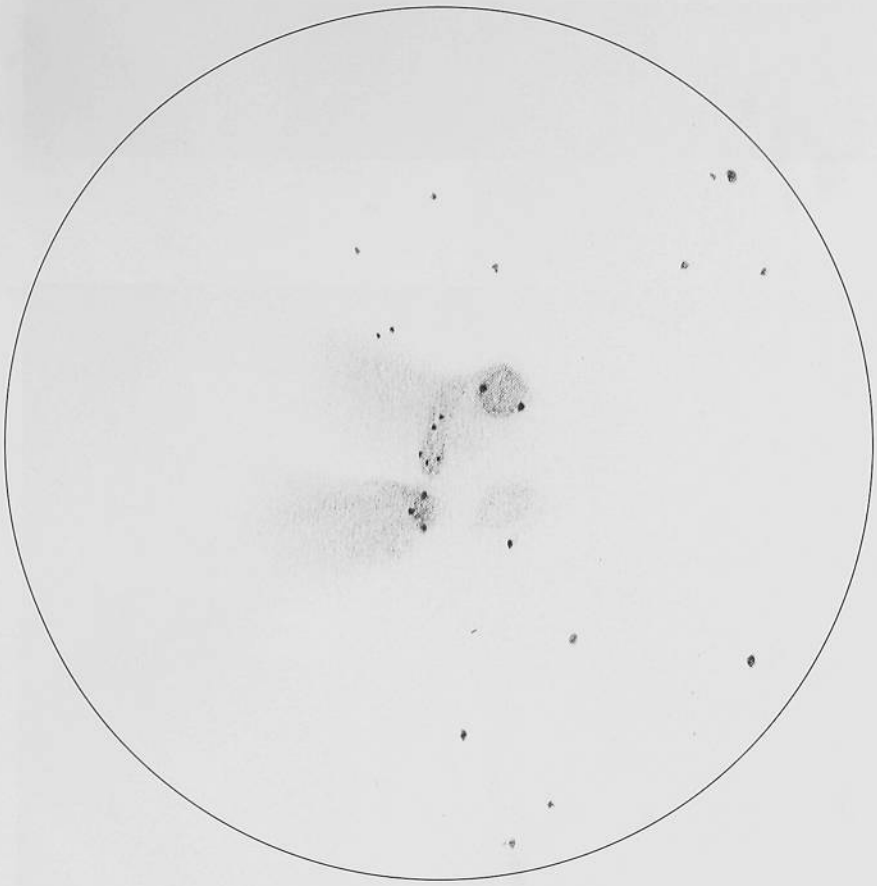
NGC 7448: This galaxy was easily found in less than great skies. It appears to be elongated and measures approximately 4' by 1.5', lying between two 10th-magnitude field stars.

NGC 7454: This object was found easily in a rich star field and lies immediately southeast of a 10th-magnitude star. The galaxy is round and about 2' in diameter, has a strong central condensation, and was visible best with averted vision.

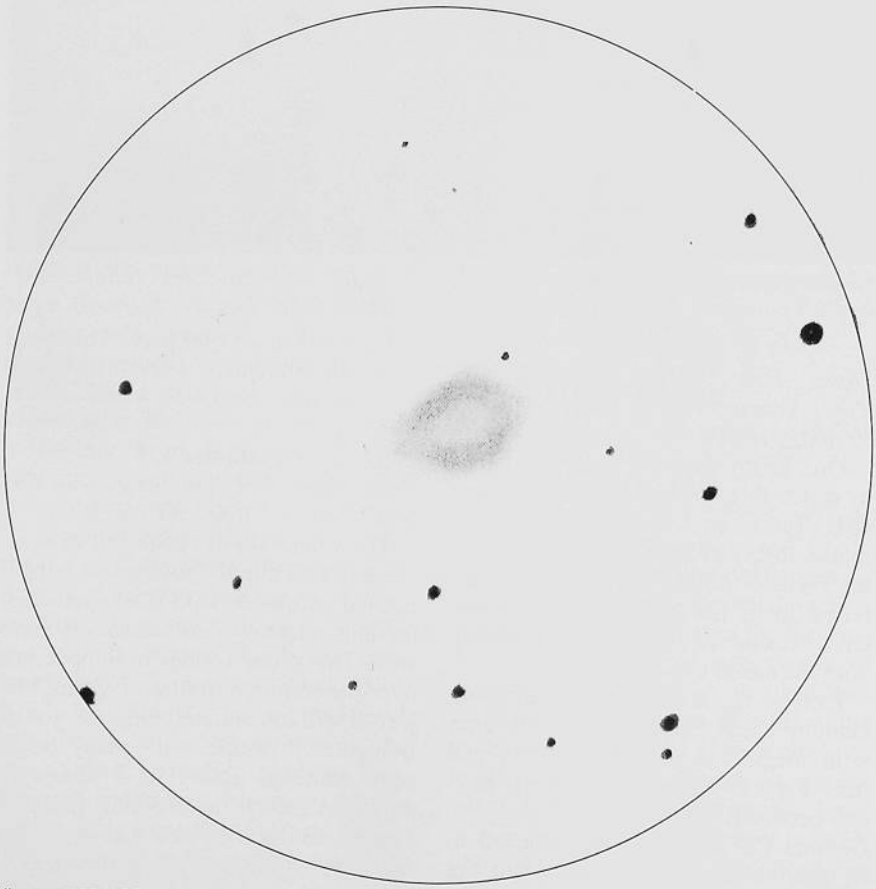
NGC 7469: This was another galaxy I found without trouble. A companion galaxy, designated IC 5283, lies immediately north and appears to be part of the larger object. NGC 7469 has a bright, stellar nucleus and nebulosity appearing about 2' in diameter. It lies just west of two bright field stars.

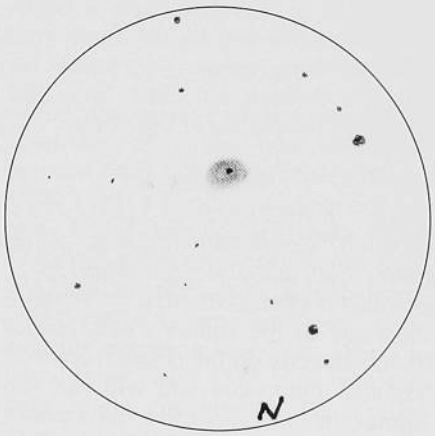
Next issue we'll continue to print as many reader observations as we can, and we'll feature Coma Berenices with an eye on NGC 4565, NGC 4340, NGC 4350, the Coma star cluster, and the Coma galaxy cluster. □

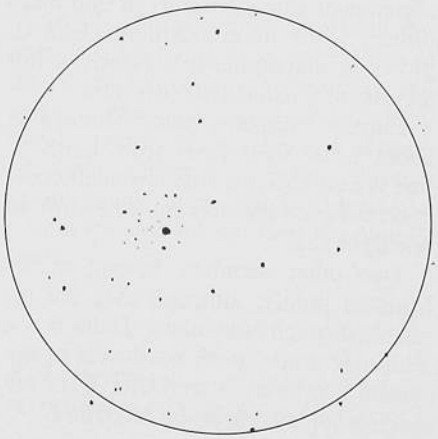
Steve Coe is an enthusiastic observer living in Glendale, Arizona.



Top left: IC 410 sketched by Tom Polakis with a 13.1-inch f/4.5 reflector at 62x and an O III filter.
Bottom left: M57 sketched by Gordon Bond with a 10.1-inch f/4.5 reflector at 84x.
Top right: NGC 1664 sketched by Dennis E. Hoverter with an 8-inch f/4.5 reflector at 90x and a Deep Sky filter.
Middle right: IC 2149 sketched by Steve Coe with a 13-inch f/5.6 reflector at 270x.
Bottom right: NGC 1857 sketched by Colin Russell with a 9-inch f6 reflector at 104x.







Deep Sky Reports

Winter's Challenging Deep-Sky Objects

by Phil Harrington

While most amateur astronomers yearn for larger apertures, I like to go the other way! I enjoy seeing just how much can be seen through smaller instruments — specifically, through binoculars. What began as an informal pet project of mine two decades ago has just materialized into my first book, *Touring the Universe Through Binoculars* (John Wiley and Sons, New York, 1990).

Have you ever really tried to make full use of binoculars? I mean, really push them to their limits? You just might be surprised by what you can see. Over the four years it took to write the book, I assembled a list of more than 1,200 challenging deep-sky objects for binocular users. Here are but a select few.

On the next clear, moonless night, leave your telescope at home and try your luck with these sights. And after you come in and defrost for a while, drop me a line and let me know your reaction. Who knows — touring the universe through binoculars may just become a pet project of yours, too.

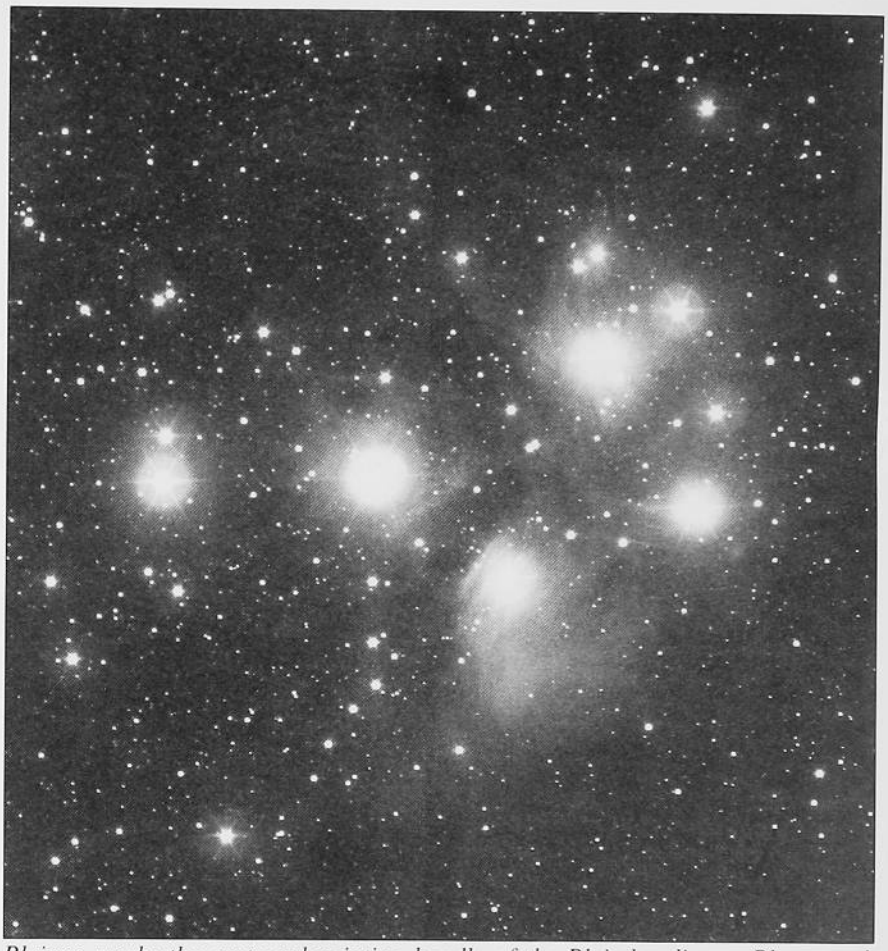
Mintaka

Stats: R.A. 5h32.0m, Dec. -0°18' (2000.0). Constellation: Orion. Magnitudes: 2.2 and 6.3. Separation: 53".

Mintaka (Delta Orionis), the westernmost star of the Hunter's belt, resides almost directly on the celestial equator. Through binoculars you will see that Mintaka is not a single star but a pair of type-B blue-white stars. The star's A component shines brightly at 2nd magnitude, while its companion, Delta C, glows at magnitude 6.3. Nearly a full arcminute separates the two stars.

Current estimates place Mintaka at about 1,500 light years from Earth. If that is true, then the true physical separation between the stars must be close to one light year.

Two other members belong to the Mintaka family, although they are invisible through binoculars. Delta B is a 13th-magnitude speck southwest of the system's primary star; Delta D is the spectroscopic companion of Delta C.



Pleione marks the eastward-pointing handle of the Pleiades dipper. Photograph by Rick Dilsizian, who used an 8-inch f/1.5 Schmidt camera.

Pleione

Stats: R.A. 3h49.2m, Dec. +24°08'. Con.: Taurus. Mag. range: 4.8-5.5. Period: irregular.

One of my favorite winter variables to watch through binoculars is Pleione (BU Tauri) in the Pleiades. Pleione marks the eastwardly-aimed handle of the Pleiades dipper. It is frequently referred to as the group's "seventh sister," because of its marginal visibility with the naked eye.

Pleione is classified as an irregular Gamma Cassiopeiae-type variable star, with magnitude extremes of 4.8 and 5.5. Typically, this type-B8V star hovers between magnitudes 5.3 and 5.5. Gamma Cas variables are believed to be hot, swiftly rotating stars that are losing mass at a rapid pace. This mass loss will ultimately lead them away from the main sequence.

Collinder 135

Stats: R.A. 7h17.0m, Dec. -36°50'. Con.: Puppis. Mag.: 2.1. Size: 50'.

The winter sky is chock full of open clusters awaiting the roving eyes of binoculars. Collinder 135 is an open cluster that relatively few observers have seen. This group resides in Puppis, just over the southern border of Canis Major. It will immediately impress you as triangular in shape, with many bright stars scattered across its 1° diameter. Brightest of all is 3rd-magnitude Pi Puppis. Binoculars also nicely display the wide, 4th-magnitude double star v^1

and v^2 Puppis, which marks a second corner of the triangle. Completing the figure is a single 5th-magnitude star on the cluster's northern edge. Collinder 135 contains at least a dozen fainter stars, all of which are visible in 7x glasses.

NGC 1851

Stats: R.A. 5h14.1m, Dec. -40°03'. Con.: Columba. Mag.: 7.3. Size: 11'.

The winter sky is conspicuously free of globular clusters, with only three readily visible to northern hemisphere amateurs: M79 in Lepus, NGC 2419 in Lynx, and NGC 1851 in Columba. NGC 1851 is an unsung hero of the winter sky, perhaps because of its low altitude above our southern horizon. Even with a good view to the south, NGC 1851 is a real challenge to find in binoculars and telescopes alike, as it is located out in the middle of nowhere in southwestern Columba.

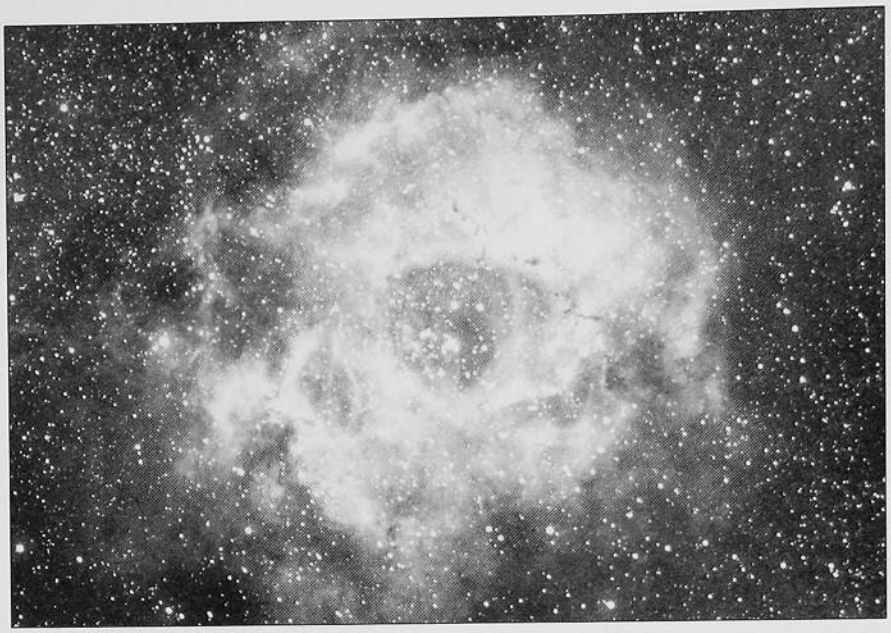
Once you spot NGC 1851, however, it stands out quite well. With a magnitude of 7.3, it appears as a small, fuzzy patch of light through binoculars and smaller telescopes. Ten-inch and larger scopes begin to resolve some of thousands of individual stars that compose this group, which lies at a distance of 35,000 light-years. Interestingly, NGC 1851 has also been identified as an X-ray source, perhaps indicating the existence of a central black hole.

The Rosette Nebula

Stats: R.A. 6h32.3m, Dec. +05°03'. Con.: Monoceros. Mag.: ? Size: 80'x60'.

Binoculars are ideal for studying large deep-sky objects such as open clusters and emission nebulae. Undoubtedly most of us are familiar with NGC 2244, a strikingly beautiful open cluster in northern Monoceros about 9° east-southeast of Betelgeuse. Binoculars display half a dozen 6th- and 7th-magnitude stars (including yellowish 12 Monocerotis) within the cluster's 24' diameter. Collectively, they form a distinctive rectangular pattern.

Surrounding the stars of NGC 2244 is a gigantic wreath of emission nebulosity called the Rosette Nebula (NGC 2237). Spanning 80' by 60', the Rosette is difficult to see through telescopes due to their restrictive fields of view. Through binoculars, however, the dim wisps of the Rosette are clearly perceptible if viewed under crystal clear skies.



The Rosette Nebula in Monoceros is a fabulous challenge object for large binoculars. Photo by Chuck Vaughn (500mm f/4 lens, hypered Tech Pan film, Hα filter, 60-minute exposure. Left: NGC 1851 is a southern globular that is visible during the winter. It is a challenge for binoculars. Photo courtesy National Optical Astronomy Observatories.

Seven-power glasses begin to hint at the cloud's existence, while 11x80s show some of the complex knots that are so prominent in photographs. Although nebula filters are recommended to see the Rosette, they are not absolutely necessary if skies are extremely clear and dark.

NGC 1360

Stats: R.A. 3h33.3m, Dec. -25°51'. Con.: Fornax. Mag.: ? Size: 390".

NGC 1316

Stats: R.A. 03h 22.7m, Dec. -37°12'. Con.: Fornax. Mag.: 8.9. Size: 4' by 3'.

Our last two binocular challenges lie in the faint southern constellation Fornax. Fornax is best known for the Fornax Galaxy Cluster, a rich swarm of galaxies crammed into an area less than 2° across. The brightest member of the Fornax cluster is NGC 1316, a most unusual galaxy indeed. For years, astronomers have been divided on the issue of NGC 1316. Some believe it is an elliptical, while others are convinced it is a lenticular galaxy. Photographs reveal great loops of swirling material leaping outward from NGC 1316 and engulfing NGC 1317, a smaller neighboring system. Some astronomers think NGC 1316 will ultimately swallow up NGC 1317 in a case of "galactic cannibalism."

Unfortunately we cannot see these amazing events in binoculars. Binoculars display NGC 1316 as a relatively large, bright, circular disk. Giant glasses add a brighter central core to the otherwise featureless disk.

Another Fornax object is within our own galaxy. Lying in an empty area of the sky that is usually bypassed by observers, planetary nebula NGC 1360 may be seen as a faint, oval disk of grayish light. Observers peering through "giant-giants" might also be able to spot a faint foreground star near the cloud's center. □

Phil Harrington is an experienced observer living in Smithtown, New York.

Deep Sky Reviews

A Universe of Words

by Mark J. Coco

The Guide to Amateur Astronomy by Jack Newton and Philip Teece, (Cambridge University Press, 1988), ISBN 0-521-34028-4, hardcover, 327 pages, $24.95

Recently several astronomy books have been published that fall into the general observing catagory. This is fortunate, because getting started in amateur astronomy can be a frustrating experience. Trying to learn the sky, the nomenclature, and the various techniques can seem impossible. Most of us relied on a patient friend to teach us the ropes simply because books on the subject were often dry and incomplete. But this is no longer the case. *The Guide to Amateur Astronomy* by Jack Newton and Philip Teece is a well-written and well organized book designed primarily for someone getting started in amateur astronomy. It covers everything from making a telescope to using one, both visually and photographically.

But *Amateur Astronomy* is more than an introduction to observational astronomy. In addition to covering the basics of amateur astronomy, the book covers more advanced information as well. Experienced observers looking for new challenges or observing programs will also find the book useful. Most importantly, the material is presented in a manner to get the reader actively involved in astronomy. The enthusiasm and experience of the authors is evident throughout the text.

The book is broken down into five major sections, each dealing with a different aspect of amateur astronomy. The first section covers the fundamentals of amateur astronomy and begins with a poetic introduction to the night sky. Newcomers will find this alluring, while more experienced observers will find this a refreshing meditation from which they can draw similar memories.

But the poetry quickly gives way to the substance of amateur astronomy. Information on learning the stars and constellations with the naked eye is presented. The tools needed to help in this endeavor, such as star charts, are discussed at length. The topic then moves on to more commonly perceived equipment like telescopes, eyepieces, and mounts. The authors discuss each type and consider the advantages and disadvantages of each. Tables and charts are used to summarize the text and give additional information on performance.

This section also covers the basics of astronomical observing with a focus on the different types of objects, both planetary and deep sky. In the planetary section, there is information on each planet, where to find it in the sky, how to observe it, and what you can expect to see. The deep-sky portion breaks each object down by type. A verbal description of each type of object is accompanied by a photograph to give the reader an idea of what it looks like. This section concludes with techniques on how to find objects and how to sketch them once you have found them.

The Guide to Amateur Astronomy may well become the standard by which general observational astronomy books are measured.

The second section is a mini catalog to the night sky. Newton and Teece cover the constellation of each season and highlight many of the objects found in those constellations. This guide is a welcome relief since it is not just a rehash of all the other catalogs. It is a list of some of the author's favorite objects, listed by constellation and including object designations, coordinates, and a brief description. Although the authors do not mention which coordinate equinox they have used in the text, the catalog listings use equinox 1950.0 coordinates, which may be the book's biggest drawback. As with the previous section, pictures illustrate many of the objects listed in the mini catalog. This section concludes with six star charts that show stars to fourth magnitude.

The third section covers advanced observing techniques, discussing both specific projects and techniques. Detailed descriptions of fine solar, lunar, and planetary detail are outlined for the amateur to observe. Included are special topics on observing asteroids and meteors.

Moving out of the solar system, the authors discuss double and variable stars. Tools required for serious observations, such as micrometers and photometers, are explained. This section closes with a discussion on astronomy clubs and star parties. Those interested in starting an astronomy club or reviving an old one will find the information here very useful.

The fourth section deals strictly with astrophotography. All forms of celestial photography, starting with the easiest and working toward the more advanced, are covered along with the equipment needed to perform each. The authors even cover some interesting topics that would not fall into the category of celestial photography, such as how to photograph lightning. This section is heavily illustrated with examples of what you can expect from each form of photography. But this section is not limited to just photographic technique. The authors also cover film selection, film treatment, and darkroom techniques that will help you get the most out of your astrophotos.

The fifth and final section covers telescope making, with heavy emphasis on optics. Consideration is also given to how to build an observatory. Several designs from roll tops to domes are mentioned. Even site selection is covered. I thought this was extremely useful even if you are selecting a regular observing site to set up your portable telescope. Several telescopes and observatories are illustrated to give the reader an idea of what can be done.

There were two aspects of this book that I found quite interesting, especially since they are absent from most other books. The first is that the authors are cognizant of their southern hemisphere counterparts. Most observers in the northern hemisphere relate amateur astronomy from their perspective. Southern hemisphere observers are left out. The mini catalog lists many southern hemisphere objects, and the section on polar alignment discusses techniques for aligning on the south celestial pole.

The second aspect I found refreshing was the dual approach to amateur astronomy. Currently there exists a fair degree of controversy over the role of amateur astronomers. Some amateurs believe that they must do real science

to consider themselves amateur astronomers. Others think that self-satisfaction is all that is required. To gaze at the stars and enjoy them for what they are is all that is important. But Newton and Teece approach the subject from both angles. There is useful information for the amateur who wants to make a scientific contribution to astronomy. And there is also information here for the amateur who just wants to look at the sky and enjoy. It's up to the reader to decide how he or she wants to approach it.

Jack Newton and Philip Teece have produced an excellent work that all amateur astronomers will find useful and informative. *The Guide to Amateur Astronomy* may well become the standard by which all general observational astronomy books will be measured.

Deep-Sky Objects for Binoculars by John T. Kozak, (Sky Publishing Corporation, 1988), ISBN 0-933346-50-6, paperback, 127 pages, $9.95

Binoculars are generally used by amateur astronomers to supplement views or observing done through a telescope — and for good reason. With their wide fields and bright images binoculars are perfect for locating objects in a larger, narrow-field instrument. But binoculars can also serve as the primary instrument for observers who, for whatever reason, do not have or want to use a telescope. Short storage space or limited financial resources can discourage someone from entering the hobby altogether simply because most people think they need a telescope to observe.

In reality this is not the case. To illustrate this point, the author of *Deep-Sky Objects for Binoculars* begins with a parable of two observers. Observer A thinks he needs all kinds of expensive equipment to enjoy astronomy. Observer B thinks the same way but can't afford a telescope and as a result settles on a pair of 7x50 binoculars. Observer A has so many gadgets he spends more time fiddling with equipment than observing. On the contrary, Observer B has nothing to set up or adjust, so he spends more time observing. Furthermore, Observer B is pleasantly surprised at how many objects he can see with his binoculars.

The parable is amusing, but true. The best observing tool is one that gets used. And once you use a pair of binoculars you will be astounded by how much you can see with them.

This book is intended for someone who does not yet own a pair of binoculars, so Kozak assumes no previous knowledge on the part of the reader, only an interest in astronomy. He describes the main binocular types, Porro prism and roof prism, and explains the advantages of each. Cross-section diagrams clearly illustrate the light path of each design. Features common to both types, like magnification, exit pupil, and objective diameter, are covered in excellent detail. Kozak discusses prism size, often overlooked by authors, and explains how to check a binocular for the right prisms. The author is definitely a pragmatist, sticking with practical advice first and including theory only when necessary.

The section concludes with specific recommendations based on price range.

Kozak mentions several brand names and models to assist the reader in finding the right instrument to meet his or her needs. Such concrete recommendations eliminate all the guesswork. The author's firsthand experience with many different brands lends credence to the advice offered.

The second section covers the "how-to" of deep-sky observing. Included are topics such as choosing an observing site, establishing an observing plan, and using binoculars (i.e., focusing, aiming, finding objects, etc.). These first two sections are accented with the author's subtle wit, giving the otherwise technical nature of the book a lighter side.

The third section, which comprises the majority of the book, is a catalog of deep-sky targets for binoculars. Listed in alphabetical order are most northern hemisphere constellations and objects of interest under each star group. The information includes object designation (Messier or NGC number), object type, size, magnitude, location, and comments. The author kept his descriptions short so as not to influence the reader's observations. The catalog is accentuated by a few wide-field photos that show some of the objects described in the catalog.

If the book has any drawback, it's a modest use of illustrations. Drawings or sketches of what the reader can expect to see visually would have been a great benefit. In addition, simple star charts showing the positions of the various objects would have been helpful.

The book is true to its title and covers deep-sky objects only. But considering the book's intended audience, a wider scope may have been in order. Comets, planetary conjunctions, and even auroral displays are all targets worthy of closer inspection with binoculars.

For the newcomer to amateur astronomy who is not sure how serious he or she is about the discipline, *Deep-Sky Objects for Binoculars* offers the perfect avenue to enter the realm of deep-sky astronomy. Moreover, intermediate observers will find the book inspiring and worthwhile, especially if they have made few serious binocular observations.

Bright Star Atlas 2000.0 by Wil Tirion, (Willmann-Bell, Inc., 1990), ISBN 0-943396-27-1, paperback, 32 pages, $9.95

Over the years, Willmann-Bell has established a reputation as one of the largest distributors of astronomical literature. Recently they have expanded their scope by entering the arena of publishing. And so far, their selection of books has been good. The popular *Uranometria 2000.0*, published by Willmann-Bell in the late 1980s, is now the choice star atlas among amateur astronomers. Sure to be another success is *Bright Star Atlas 2000.0*. Designed specifically for new stargazers, this laconic work is chock full of information that even seasoned amateurs will find useful.

It begins with a five-paragraph introduction on how to use the various charts found throughout the book. Since there is more than one type of chart, this is must reading. Following the introduction are six full-page seasonal star charts that show the brightest stars within each constellation. These give the reader an idea of where the constellations are located in the sky and in relation to each other. They also indicate the time of year they are visible. These charts are a big help to the first-time stargazer who has trouble getting oriented to the sky.

But the nucleus of the book consists of ten detailed charts showing stars to magnitude 6.5. Drawn by the well-known astrocartographer Wil Tirion, the charts contain over 9100 stars (from the *Yale Bright Star Catalogue*) and over 600 deep-sky objects (all Messier objects are included). Unlike the seasonal charts which only show the sky from 60° north to 40° south, the detailed charts show the entire sky, pole-to-pole. Each chart is accompanied by several tables summarizing the data from the chart.

Before the detailed charts, the author explains each object type in simple, non-technical terms. The reader gets a good idea of what each object type is and looks like.

The remainder of the book is filled with tables summarizing the data found in all the charts combined. Tables are generally arranged by object, though the complete Messier catalog is listed separately as well. Objects listed in the tables are cross-referenced with the charts so they are easily located.

Made with field use in mind, the

soft, laminated plastic cover is intended to withstand exposure to the elements. The book's soft cover and thin size make it easy to toss into an accessory bag or box and take out observing. Advanced observers will find this appealing for short observing sessions when they don't want to take larger, heavier atlases.

Bright Star Atlas is a welcome addition to any library or observing bag.

The Christmas Star by John Mosley, (Griffith Observatory, 1987), paperback, 76 pages, $6.95

Occasionally, astronomers are forced to play the role of detective, studying historical records that describe astronomical events and then finding an explanation to fit the description. Archaic explanations of astronomical phenomenon, such as comets and supernovae, are not always easy to identify and understand. Furthermore, one culture or civilization may record a major astronomical event while another makes no mention of it at all. Most often the culprit is found, but not always.

One such event, frequently speculated with no definitive answer, is the "star" associated with the birth of Christ. Was it a supernova? A bright comet? A planetary conjunction? In *The Christmas Star*, John Mosley of the Griffith Observatory answers these questions and many others as he deals with the problems associated with trying to explain this mysterious object.

Before exploring the various explanations or causes of the "star," Mosley answers key questions about the time of Christ's birth. Using well-documented astronomical events (such as lunar eclipses) and their relation to key Hebrew holidays, the author explores several possible dates. Mosley also deals with several troubling questions, like: Why wasn't that "star" noticed by the general population? Why didn't other cultures record it?

After answering these questions, Mosley turns his attention to discussing possible culprits. Novae, supernovae, comets, and planetary conjunctions are all considered as possible suspects. Each is considered carefully based on the merits of supporting evidence. Other historical records (Chinese and Babylonian) are cross-referenced to see if any such astronomical event is mentioned that coincides with the right date. Mosley's arguments are well thought out and researched, his conclusion quite convincing. (I won't spoil the book by telling the author's findings — you'll have to read it for yourself.)

The latter portion of the book contains trivial information concerning Christmas customs and ceremonies. Although it in no way contributes to identifying the "star," it is interesting. The book concludes with an extensive biography for the reader who wants more on the subject.

Those that do not have a general interest in astronomy will find the book intriguing and easy to understand. All terms are defined in the text, and quite often, illustrated with a drawing or photograph.

Mosley is to be commended for his thorough treatment of the topic. The book is well-researched, well-written, and lavishly illustrated. Many authors are reluctant to write about such topics simply because of the religious connotations. But *The Christmas Star* is excellent reading, both historically and astronomically.

Observers north of the equator will find many easy pickings . . . southern observers will have a field day.

Catalogue of Southern Peculiar Galaxies and Associations by Halton C. Arp and Barry Madore, (Cambridge University Press, 1987), Vol. I ISBN 0-521-33086-6, hardcover, 216 pages, $48, Vol. II ISBN 0-521-33087-4, hardcover, 288 pages, $60, or Two-Volume Set, ISBN 0-521-34336-4, $125.50

For some reason, most amateur astronomers overlook the professional literature. It may be that they think they have no use for it as observers or that the subject matter is over their heads. But the truth is many professional astronomers produce books that appeal to amateur astronomers. *The Catalogue of Southern Peculiar Galaxies and Associations* is one such work. In fact, amateurs will find more than one use for this unique two-volume set.

The Catalogue of Southern Peculiar Galaxies and Associations, which complements Arp's original *Atlas of Peculiar Galaxies*, is intended for optical astronomers interested in follow-up research on particular galaxies. As you would expect from a professional work, all the images were made with professional instruments. But don't let that deter you. Many of the objects in this catalogue are within the reach of amateur telescopes. Advanced galaxy observers will find many new challenges here, especially when you consider these are anomalous galaxies which require advanced observing skills to pick out their unusual features. And, even though the catalog highlights southern galaxies — the northern most entries are about -22° — observers north of the equator will find many easy pickings, depending, of course, on their latitude. Southern hemisphere observers will have a field day.

The catalog is broken down into two volumes: Volume I, which is the catalog itself (descriptions and positions), and Volume II, which contains selected photographs.

Volume I begins with descriptions of each peculiar galaxy category (i.e., ring galaxies, interacting doubles, galaxies with jets, clusters, groups, chains, etc.), of which there are 24 total. The authors explain why a galaxy is classified in one category when in actuality it may fit several. For example, a galaxy with a jet may also have a companion and deserve entry into both.

The remainder of Volume I is the catalog. Using an AM code (for Arp and Madore) entries are listed in right ascension order. Each entry includes coordinates (1950 equinox), annual precession, galactic longitude and latitude, and a description (i.e., cluster, ring, group, interacting pair), classification, and cross-reference catalog (eg., NGC, IC, PKS). An asterisk indicates when an entry is illustrated in Volume II. Unfortunately, there is no mention of magnitude, information that would have been extremely useful to amateurs.

Volume II illustrates many of the entries listed in Volume I. Photographs are grouped by category so all "like" galaxies are together. In addition, categories are broken down further in subcategories. For instance, jets from E galaxies, jets from spirals, jets from companions, etc. All photos are reproduced as negative prints that offer excellent image contrast.

In the amateur community, this book is not limited to serious galaxy observers. On the contrary, the second volume is especially suitable as a show book that may adorn a coffee table or the like. The high-quality photos will be appreciated by astronomers and non-astronomers alike.

Additionally, amateurs can use this work as an instructional guide to learn more about peculiar galaxies. Most as-

tronomy texts gloss over the topic and highlight only a few examples. This work provides the most detailed listing of peculiar galaxies anywhere.

Although the book's price is rather high, the numerous and diverse uses for this work makes it well worth the investment. If that doesn't sell you, consider this: The two-volume southern hemisphere edition is about $30 less expensive than Arp's first peculiar galaxy atlas, which was only a single volume.

Star and Planet Spotting by Peter Lancaster Brown, (Sterling Publishing Company, Inc., 1990), ISBN 0-8069-7268-8, paperback, 148 pages, $8.95

Most sky guides aimed at the newcomer to amateur astronomy fall into the same trap — they try to cover too much and as a result, don't do anything well. In fact, several of these sky guides look like clones — same content, same overall organization, same illustrations, just a different publisher and a different title. Unfortunately, *Star and Planet Spotting* falls into this category. Originally published in 1974, this entry-level guide has just been revised to include updated planetary information. Other than that, not much has changed.

The majority of the book is devoted to deep-sky observing and the equipment needed to do so. The author begins with a brief introduction to the nature of the stars. This includes a discussion of the different types of objects visible in the night sky, ranging from double and variable stars to nebulae and galaxies. Some of the descriptions are too brief and confusing, leaving the reader wanting. I have found that many general texts, including *Star and Planet Spotting*, have difficulty explaining the various types of supernovae and how they differ from novae.

Next, the author jumps into equipment; he emphasizes binoculars and, to a lesser extent, small telescopes. Practical observing hints are also mentioned.

After this come the sky maps, broken up into two sets: seasonal charts meant to identify specific constellations and their position relative to each other, and detailed star charts which show stars down to about magnitude 6 and some of the brighter deep-sky objects.

The majority of the book is the constellation listing which highlights several deep-sky objects within each. Constellations are broken down by declination, listing northern, equatorial and southern constellations in different groups. Within each group the constellations are listed alphabetically. The object descriptions are good and the author often gives aperture and magnifications required to see each.

The final portion of the book covers planetary observations. Mentioned are tips and techniques for observing the planets, comets, meteors, the zodiacal light, and auroral displays. Included are tables listing the positions of the Sun and the five naked eye planets for the next decade (hence the reason for updating the book). The only problem is the objects are listed by celestial longitude, something which a first-time stargazer may have trouble understanding. The author would have been better off to include right ascension and declination coordinates with a cross-reference to a specific chart.

The book concludes with a glossary that is virtually useless. Of the seven entries (yes, you read that correctly — *seven*) only two relate to entry-level observational astronomy. This could have been left out without affecting the book at all.

The author's style is easy to read and flows very well. But the continual replication of introductory sky guides gets old fast. Let's see something different, something that will grab the readers and get them out observing, which is the point in the first place.

Through the Telescope: A Guide for the Amateur Astronomer by Michael R. Porcellino, (TAB Books, 1989), ISBN 0-8306-3159-3, paperback, 342 pages, $18.95

Over the last few years several new telescope user's guides have been published. Designed as springboards for developing further interest in the hobby, these books provide a cursory treatment of telescope use and information about observing. *Through the Telescope* is one of the latest in this category, and like others, it covers the usual assortment of topics important to the newcomer in amateur astronomy. However, unlike many other telescope user's guides, this book contains numerous factual errors that severely limit its usefulness.

The book begins with a short history of amateur astronomy. Recollections of early observers are brief, but inspiring. The author then moves into the tools of amateur astronomy, beginning with the human eye. The author's treatment of the subject is good and one that is often overlooked by most writers of amateur observing guides. The section that follows treats binoculars and is also very good. Porcellino not only describes the different types of binoculars but also the features to look for when purchasing a pair.

But after this the book takes a turn for the worse. In the chapter on telescopes the author makes focal length and f/ratio the key criteria for determining whether or not a telescope is suitable for deep-sky observing. The underlying reasoning is that long focal lengths are good for planetary work while short focal lengths are desirable for deep-sky work. This premise leads to many false statements, such as "refractors are not good for deep-sky observing." What's really frustrating is that the key feature of importance, aperture, is completely overlooked by the author.

A few chapters later the author discusses image orientations as seen through the telescope, a very important topic. Unfortunately, statements about image orientation are vague and sometimes contradictory. The full-page illustration that shows various field orientations is wrong.

The remainder of the book, which deals with specific types of observing, is riddled with technical errors, ambiguities, and inaccuracies. For example, the author states that the dust tail of a comet glows, when actually it is visible by reflected sunlight. He defines an emission nebula as a bright nebula that is illuminated from behind when it is really a gas cloud that is excited into luminescence by a hot star. He refers to a nova as a scaled-down version of a supernova, which is not true of a Type II supernova. Furthermore, the confusing references to image orientation that began in the section on telescopic images continue throughout the book.

I could go on. Most of the problems with this book could have been avoided by more thorough research and some degree of careful editing.

I was extremely disappointed by the photographs in the book, not so much by the quality as by the type. In a book of this sort I expect most photos to be made with amateur equipment, to give the reader a good idea of what he or she can expect to see with amateur equipment. However, the vast majority of the photos in *Through the Telescope* were produced with professional equipment, either at major observatories or with NASA spacecraft.

This book's many errors will mislead and confuse its readers. As a result, I cannot recommend *Through the Telescope*, especially when there are so many well-done books on observational astronomy already in print. □

Mark J. Coco is an expert observer, astrophotographer, and author who is also a staff member at Celestron International in Torrance, California.

Small Scope Showcase

The Depths of Winter

by Alister Ling

So you've seen most of the sky? Most likely you've dug about as deep as possible in Sagittarius, sifting through the treasures fading into the thick atmosphere hugging the horizon. I've known some people up here at 45 degrees north latitude to pick up a couple of clusters below the tail of Scorpius.

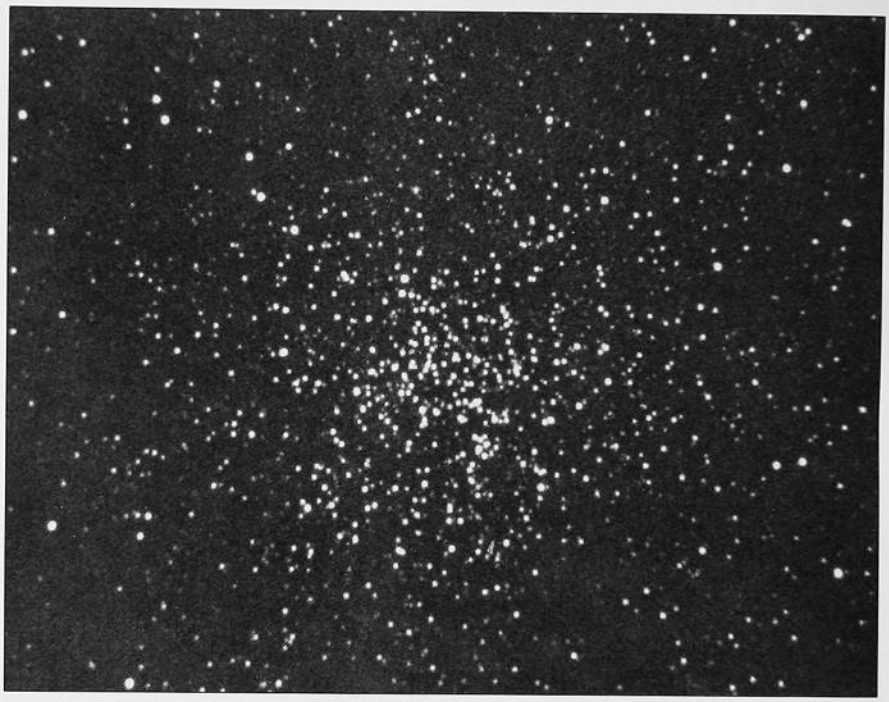
But have you ever tried for the depths of the winter sky? To many it seems like Canis Major just fades away to the south. If you have the proper warm parka and insulating pants, it's well worth the trip. Whether you have a small scope or a large one, there is much to delight the appreciative eye.

Starting in the far north of our southern sky, we can use **M93** (NGC 2447) as a good kickoff. Even from the city, this bright cluster in Puppis stands out well from the background, appearing as a tight knot at low power. Medium power breaks it into a host of fainter stars, aligned roughly east to west with the bright wide pair of stars preceding the group.

One inviting green box just 3° southeast of M93 on *Sky Atlas 2000.0* is labeled **NGC 2467.** Although it was bright enough to make it into *Burnham's Celestial Handbook*, it doesn't show up on the popular charts. William Herschel called it "pretty bright" and 8-10' across. He even thought he saw some red color in the object. John Herschel did not add any significant comments, but then neither he nor those who followed have the advantage of technology's child: the O III nebula filter.

With this modern wonder accessory, the nebula gets my rather unscientific rating of very bright. It simply jumps out of the field at you. Only the main part of the nebulosity is visible in a 4.5-inch scope, but a 17.5-inch scope starts pulling in new wreaths of nebulosity visible on the *Palomar Observatory Sky Survey*. How many more astounding sights in the winter sky are waiting for the "magic" of the O III?

I've heard some pretty negative remarks about the O III at star parties, especially from the owners of the smaller scopes. It seems that the major problem is they are not using dark hoods to keep out stray light, which causes ghosts after reflecting from the back of the filter.



NGC 2477 is a huge cloud of faint stars that is especially striking in small telescopes. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 30-minute exposure).

After all, one gets into the habit of not needing a hood for planets or other bright objects. The O III darkens the field so much that the observer doesn't even realize that they need their eyes to dark-adapt further. Another common mistake is to use the filter for reflection nebulosity, which does not send us many photons near 500 nanometers. Use it properly and the rewards are great.

Two astounding sights lie just below the horizon from back home in Edmonton, Canada. High overhead from Australia they are almost without parallel in the sky, but the Double Cluster in Perseus wins one for the north. **NGC 2451** and **NGC 2477** lie a rich field apart, providing a nice contrast between two delightful but quite different open star clusters.

Even in my 4.5-inch scope, NGC 2451 seems to spill out of the low power field and slowly merge into the faint but rich Milky Way. The number of bright field stars is amazing. Smack in the middle of the cluster lies 4th magnitude **c Puppis**, a star with a strong orange color. To me, the faintest stars of the group seemed to clump together in groups of four and five, at least from city skies. Under dark dry Australian skies this unusual pattern is lost amidst the myriad companions.

My observing buddies in Melbourne have nicknamed NGC 2477 "Charlie's globular." One night Charlie stumbled on the big smudge in the finder, then was astounded at the eyepiece view. He quizzically wondered aloud how such a magnificent globular could have made its way into Puppis without being famous.

It is easily the equal of Auriga's M37 — dare I say better? It's also a bit like M11, the Wild Duck cluster in Scutum, except much richer. The misty patch in the finderscope is reminiscent of the bright globular M22 in Sagittarius. The open cluster NGC 2477 is a wonderful spectacle that meets the eye, certainly nicer than many actual globulars.

Puppis and Pyxis are certainly the kingdoms of the open clusters, sprinkled with a couple of mostly small planetary nebulae. Heading further south to Vela, we find an additional number of clusters. Some have quite a

NGC 2467 is a bright emission nebula in Puppis that is visible in small telescopes with the aid of an O III filter. Photo by Preston S. Justis (10-inch f/6 reflector, hypered Tech Pan film, 80-minute exposure.

few members plotted on the *Sky Atlas 2000.0*. Despite its non-NGC status, **IC 2391** is visible to the naked eye as a nonstellar fuzz. It sports a full dozen stars compared to M35's faint three plotted on the *Atlas*. But then it doesn't have the backup stars. Both have a faint companion cluster. I find it intriguing to draw comparisons between the famous northern objects and the relatively unknown southern ones.

Even if you can't make it to Australia to view these objects in the comfort of a T-shirt and sandals, many of them are still accessible to the backyard or the warmer climes of Arizona. Don't miss out.

Much has been said about the importance of collimation in large scopes, and that small scopes are less affected. To a certain extent this is true, but a longer focal ratio than f/4.5 doesn't excuse you from tweaking the optics to get great images. In fact, I have found that collimation can make a world of difference even for an f/8 scope.

The experience that jolted me into collimating was seeing Jupiter's belts for the first time in my 4.5-inch scope, after two years of observing! You can imagine my delight, being able to share this with my family. Until then, I could only tell them of the purple belts that I had seen in our club's 8-inch SCT.

Of course precise collimation will not help too much on large diffuse objects — or will it? Most deep-sky observers use their scopes at a power too low for collimation effects to badly twist the images. Ensuring that the photons go to their proper places means that faint stars will be tiny points instead of being nonexistent. Subtle features like galaxy cores and the odd H II region will stand out. Star clusters will be more resolved — the hazy background will be alive with glittering points!

There may very well be a feedback loop for non-collimation that an observer will think: "High power is difficult to maintain, the images frequently aren't good, they're pretty dark, so therefore it is not worthwhile to use high power, because the low power images are okay. Ten minutes of collimation does not really improve the images at low power, so why get frustrated?"

Even after a scope has been properly aligned, the seeing may hide the improvements. Or worse yet, astigmatic images from Erfles or other old designs (which cannot handle the faster light cones) swamp sharpened images. It takes a fair amount of patience to wait until the night is right to spend time collimating and checking out high power. It took me three nights to verify that my f/5.6 scope could handle a 4.8mm Nagler, borrowed from a friend at a star party. Now I routinely use the 4.8mm and wait patiently for the seeing cells to bring me details in spiral arms and close doubles in clusters. Consider buying some collimating tools to make the job faster and more precise. The extra bit of frustration is a small price in exchange for subtle, wonderful detail showing up in nebulous or starry backgrounds. □

Accomplished observer and author Alister Ling is an expert at using telescopes both small and large.

Double Stars

A Survey of Triangulum

by Brian Skiff

Although I've been regularly distracted in this column with special features, I'd like to return this time to a continuing general survey of the sky's brighter and more interesting doubles. As explained several times in the past, the "bright, interesting" sample is derived from the listing in *Sky Catalogue 2000.0*, Volume 2 (which many folks refer to as *SkyCat*), edited by Roger Sinnott and Alan Hirshfeld. The full list there includes all cataloged pairs with a combined magnitude brighter than 8.05, making it jibe more-or-less with the popular *Sky Atlas 2000.0* by Wil Tirion.

From this rather lengthy list I make up observing lists by constellation, selecting only those between about 0".5 and 10" separation. Wider pairs are just too wide (unless they are naked-eye stars) to qualify as "interesting." The close limit is set by the resolution of my 6-inch refractor, which resolves pairs to 0".85 (the Rayleigh limit), but can show merged Airy disks of much closer targets. A further cut it made by omitting those with very large magnitude differences. This process trims the all-sky list to perhaps 2,500 pairs, less than a third of the full catalogue.

Even though using *SkyCat* is a great way to make up observing lists, the data for individual stars is not up-to-date, particularly for close, rapidly-moving binaries. Thus for this article I have gleaned more recent measures and (in a few cases) improved magnitudes from the professional journals for the stars discussed, as noted below.

Taking things in order, then, we start with a pair fainter than the *SkyCat* limit, but which lies near Triangulum's only showpiece deep-sky object, Messier 33. **ADS 1243** lies about 45' northeast of the center of the galaxy, outside the boundary of the easily visible part. During a recent observation of the galaxy itself I used the pair as a benchmark to establish the extent of the halo at just 30x, deciding it reached at least two-thirds the distance from the center of the galaxy to the star, which appeared single, but as soon as I switched to 50x in my 6-inch refractor, the star was resolved into a very close, somewhat unequal double separated east-to-west. The *Washington Catalogue of Visual Double Stars* (*WDS*) gives the magnitudes as 9.0 and 9.8 with a separation of 3".4 in p.a. 87° measured in 1976. Obviously, this pair should be nicely resolved in fairly small instruments, although higher power may be required. Because of its relative faintness, it may be a challenge in a 2.4-inch refractor.

A definite challenge for larger apertures is **ADS 1522**, a triple system comprised of a very close pair and a distant companion. The wider pair (ABxC) has a separation of 5".6 in p.a. 162°. I found them easy at only 50x in the 6-inch scope. At higher power I estimated the magnitude difference (Δm) as 1.5. The combined brightness of the trio is V = 7.36, but because there are three stars involved, it is difficult to assign precise magnitudes for each component. The *WDS* gives magnitudes of 7.8 and 8.7 for A and C, with the close B component coming in at 8.5. The combined magnitude suggests these are about right if the magnitude differences are correct.

The most recent published measurement of the closer AB pair is 0".31 in p.a. 168°, a late-1988 speckle-interferometry result by Harold McAlister and colleagues from Georgia State University using the 4-meter Mayall telescope at Kitt Peak. This is close enough to the prediction from the most recent orbit, by Paul Couteau, and I have included an ephemeris for the coming years from the *Fifth Catalogue of Ephemerides of Visual Double Stars*. The separation will change little while the position angle drifts slowly in retrograde motion. This pair is well beyond the limits of the 6-inch scope, and I have not tried for them with a larger telescope. Based on the magnitudes and separation, they should be recognizable with a first-class 12-inch telescope, and right at the true resolution limit with a 16-incher. Such pairs are not only tests of telescope optics but also seeing, which becomes crucially important with larger apertures. Thus it may take several attempts at 600x before you get a night steady enough to resolve them.

A more routine pair is **ADS 1562**. It has the distinction of lying only 3' east of the merged galaxy pair NGC 750/751. In the predawn hours of an August morning in 1988, I resolved these stars in the 6-inch at 80x. At 165x I estimated the Δm as 0.6 and the position angle at 225°. A 1985 measure put them 1".59 apart in p.a. 231°. The *WDS* gives the magnitudes as 8.9 and 9.2, implying a rather smaller Δm than I observed. Perhaps a reader can make an independent check on this.

Epsilon Trianguli is an excellent pair showing a large difference in brightness, amounting to six magnitudes. The primary glows at V = 5.4; the 11th magnitude companion lies at just 4".0 in p.a. 120°. Were they equal in brightness, they would be easy to spot at low power in my 6-inch scope as well as being among the best doubles in the sky! But I needed 165x to pick out the secondary. In the field about 5' south-southwest is a wider, faint pair, catalogued as **Scheiner 21**. Its stars were easy to spot at 80x. The *WDS* gives magnitudes 10.7 and 11.1, with a separation of 9".3 in p.a. 82°.

Another bright pair is **ADS 1697**, also known as the variable TZ Trianguli. On old sky atlases, it is sometimes labelled Iota Trianguli, but this designation is no longer accepted; the Flamsteed number (6 Tri) is still valid. The primary is an RS CVn-type binary of small amplitude. This is one of very few pairs where the fainter star is bluer than the primary; the primary includes a G giant as its dominant star, whereas the visual companion is an F-type dwarf. With magnitudes of V = 5.3 and 6.9 and a separation of 4".0, the stars are a good target for the smallest of telescopes. The B-V color difference has been measured to be 0.37 magnitude. However, using the Lowell 24-inch Clark refractor stopped to 6-inches aperture, I could not see any obvious color difference. At larger apertures the

chromatic aberration of the objective precluded accurate assessments of star color.

In the same low power field with ADS 1697 is **ADS 1723**, which I spotted at just 30x in the 6-inch scope. The *WDS* and *SkyCat* list both components as magnitude 8.0 with a separation of 6".6 in p.a. 246°. My notes indicate a slight Δm of 0.2 — they're definitely not equal — and a p.a. of about 65°, 180° different from the cataloged value. This is probably a case where the quadrant was reversed in early observations and has been preserved subsequently since the components are so close in brightness.

Another easy pair for low power is **ADS 1764**, despite being fairly faint. The *WDS* magnitudes are 8.2 and 9.4, with a separation of 10".0 in p.a. 123° last measured in 1975. At 165x, I estimated the Δm to be 1.0 (close enough) and a position angle of 130° (likewise).

ADS 1868 is a tougher object for the 6-inch scope, requiring 165x for a good view due to the magnitude difference. At 295x I estimated a Δm of about 2.0 and a position angle of 330°. The *WDS* magnitudes 7.9 and 10.2 imply a Δm = 2.3; a 1984 measure gives 1".79 separation in p.a. 346°.

A nice pair for the 6-inch scope is **ADS 2004**, coming in at 1".6 separation in p.a. 165°. The stars are mag. 7.5 and 8.2. I can usually recognize pairs with similar specs at 80x, but really need rather higher power to make good estimates of Δm and position angle. Because they are relatively easy but still pretty close, they make good examples for those just getting started in viewing doubles with a moderate aperture. At medium power their apparent distance is quite small but they are so obviously not single stars, and the contrast with other single stars in the field is visually striking — one of the things that makes double star observing more interesting than most deep-sky observers would admit.

1522
01494 N2818
STF 183
COUTEAU 1973
p = 368.00

166.1	0.31	1988
164.8	0.32	89
163.5	0.32	90
162.2	0.32	91
160.9	0.33	92
159.7	0.33	93
158.5	0.33	94
157.4	0.34	95
156.2	0.34	96
155.1	0.34	97
154.0	0.34	98

We'll close off with three similar-looking pairs, two of which are in the same lower field. **ADS 2020**, **ADS 2146**, and **ADS 2150** all have primaries about magnitude 8 and relatively faint companions near magnitude 10.5; their separations all lie between 2".5 and 3".0. Since they have faint companions, I needed 165x to pick them up in the 6-inch scope, but otherwise they were not more than ordinarily difficult. ADS 2146, the faintest overall of the three, lies 35' north of ADS 2150.

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Scanning the Literature

Galaxies and Their Magnitudes, Part III

by Brian Skiff

So far in this series we've talked about the definition of the commonly-used UBV photometric system, the concept of "total" magnitudes (V_T or B_T) for galaxies, and the sources of systematic and accidental errors in some older sources of magnitudes for galaxies. Until the publication of the *Second Reference Catalogue of Bright Galaxies* (*RC2*) in 1976, the notion of total magnitudes for galaxies was not on firm analytical footing. Magnitudes published in all large catalogs up to that time had problems of various sorts: They were not on standard photometric color systems, they didn't include all the light from an object, and they included measurements done in an inconsistent fashion depending on how big, bright, or faint a galaxy was.

Last time I started a discussion of some well-known catalogues of galaxies that include magnitudes. The popular *Burnham's Celestial Handbook* used data from a source published in 1932. Those data were perhaps the most consistently available in the early 1960s when Burnham wrote his handbook, but they were clearly out-of-date for current use. Consequently, information in *Burnham's Celestial Handbook* should be ignored. Still popular (and useful) are magnitudes from Zwicky's six-volume *Catalogue of Galaxies and Clusters of Galaxies* (*CGCG*). For faint northern galaxies it is often the only source of information. Nevertheless, the magnitudes in Zwicky's work suffer from a complicated set of systematic problems separate from the fact that they are neither visual nor total magnitudes, which is what we seek as amateur observers in order to prepare observing lists and compare views of different objects. Zwicky magnitudes can be used, but to avoid being misled by them, amateurs should be aware of the shortcomings discussed in the previous issue.

Peter Nilson's *Uppsala General Catalogue of Galaxies* (*UGC*) is another commonly used source of information for galaxies. *Uranometria 2000.0*, which shows many UGC galaxies, has increased the popularity of the *UGC* among large-telescope owners. Several hundred UGC galaxies are plotted on *Uranometria* that do not appear in the NGC or IC catalogues. About 13,000 objects are listed in the *UGC*, including all galaxies appearing larger than 1' on the *Palomar Observatory Sky Survey* (*POSS*) prints. To provide some completeness in terms of magnitude, Nilson included objects considered by Zwicky to be magnitude 14.5 or brighter. With few exceptions, the magnitudes in the *UGC* come directly from the *CGCG*, however, so they do not help in our search for the Holy magnitude Grail. This means the *UGC* is complete to roughly $V_T = 13.5$. Some additional discussion of various aspects of the *UGC* can be found in the Autumn 1989 and Spring 1990 issues of *Deep Sky*.

One of the few genuine drawbacks of the *UGC* is that it covers only the northern hemisphere. When the *UGC* was created nearly twenty years ago, it was anticipated that southern sky atlases would soon allow extensions of the galaxy survey to the south pole. As it has turned out, the southern atlases initially went only as far north as -20° declination, so there remains a gap among published galaxy surveys in the south-equatorial zone. (One has been completed by Harold Corwin at the University of Texas, but it is not yet published.)

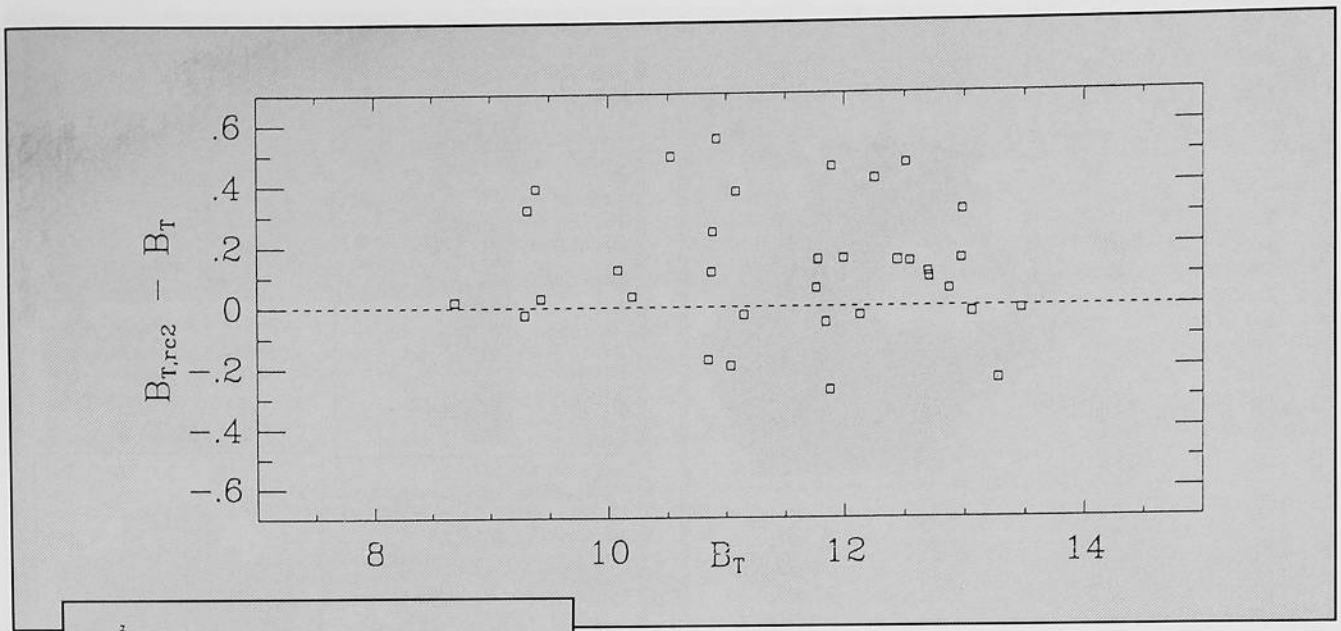
This region is covered, indeed, by Vorontsov-Velyaminov's *Morphological Catalogue of Galaxies* (*MCG*), a five-volume work extending to -45° declination. The magnitudes there, however, were intended merely as an aid in identification, and are not at all accurate, only estimates. Often galaxies called magnitude 15 (they're given only to half or whole magnitudes) are brighter than $B_T = 13.0$. But the *MCG* does provide a working list of brighter galaxies in the south-equatorial gap, and so remains useful.

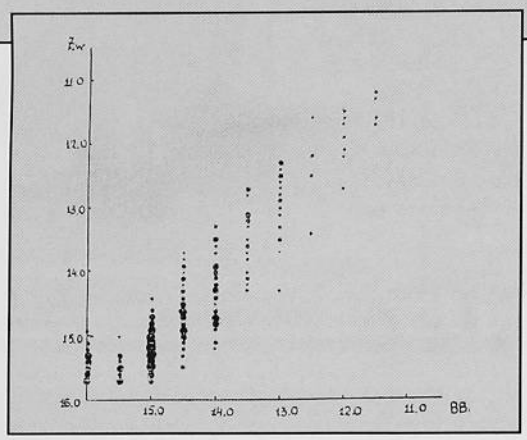
South of -20° declination, we're actually in better shape for both bright and faint galaxies thanks to the *ESO/Uppsala Surface Photometry Catalogue*, compiled by Andris Lauberts and Edwin Valentijn and published last year by the European Southern Observatory. I discussed this catalog in this column in the Autumn 1989 issue. The authors refer to the work as *ESO-LV*.

Unlike the earlier catalogues discussed so far, the magnitudes here were carefully measured and are on the standard system. The images of some 16,000 southern galaxies on plates taken with the 1-meter Schmidt camera at the European Southern Observatory in Chile were digitally scanned. The sky atlas plates were taken in two colors with emulsion + filter combinations whose sensitivity resembled the standard Johnson B (blue) and R (red) passbands. These two colors were chosen so that this survey would correspond to the two colors used for the original *POSS* plates in the north.

Thousands of photoelectric measures of galaxies appearing in each field were collected from the literature or measured anew by Lauberts and Valentijn or collaborators. These served as "standards" to calibrate the plate scans and transform the photographic galaxy magnitudes to standard systems. Great care was taken to look for and correct systematic problems such as we've discussed. As a consequence, the magnitudes in the catalogue are essentially free of the problems plaguing the Zwicky magnitudes. The average entry for B_T in *ESO-LV* has an error of only about 10 percent, or 0.1 magnitude — about as good as one can expect from careful analysis of photographic plates.

One often sees magnitudes for galaxies (and other objects) quoted as being "photographic magnitudes." Usually it is assumed this implies a blue-light measure — but little more. Obviously, photographic emulsions are readily available that respond to yellow light, or even clear out into the infrared; a "photographic magnitude" could just as easily mean the magnitude on a red-light photograph. The term merely means a magnitude determined from a photograph. But it is also important to know the wavelength range involved,





This plot shows a comparison of two high-quality data sets. Serving as standards in the southern sky, RC2 *galaxies are plotted versus the newer* ESO-LV *total B magnitudes. The* ESO-LV *B magnitudes are on average 0.13 magnitudes brighter; the scatter is ± 0.22 magnitude, which reflects a combination of the errors in both catalogs.*
Left: A comparison of the rough magnitudes in the Morphological Catalogue of Galaxies *versus those in Zwicky's* Catalogue of Galaxies and Clusters of Galaxies. *Although the* MCG *magnitudes, which are merely eyeball estimates, are close to the* CGCG *values on average, they are often a magnitude or more in error compared to the better-defined* CGCG *data.*

and as we've seen, how much of the total light is included in the value given. The *ESO-LV* data are "photographic magnitudes," but they were determined in a well-defined, consistent, and reproducible manner.

Even without explicit V magnitudes, the *ESO-LV* catalogue pretty much takes care of our problem in the south, where galaxy photometry was far less complete than in the north. Now the table is turned and we need a comparable photometric survey in the north. Because they are crucial to our understanding of the structure of the nearby universe, such surveys are underway in several camps. By the turn of the century we should have reliable magnitudes for many tens of thousands of galaxies.

But what do we do in the meantime? The primary source is the *RC2*. It lists information of all kinds for nearly 4,500 galaxies, although less than one-third of these have reliable B_Ts given. Something less than 1,000 objects also have (B-V) colors, enabling V_T to be determined. This was the situation in 1976, and much work has been done since then. The *RC3* ought to be out sometime in 1991. It will contain improved basic data for 20,000 or more galaxies. This catalog will take care of practically all amateurs' needs as far as basic data. For the brightest few thousand galaxies, the galaxy section of *Sky Catalogue 2000.0*, volume 2, will suffice for most people. It is based on the *RC2*, and so provides B_T and/or V_T, but includes Zwicky magnitudes for hundreds of objects, denoted by a special flag, since they differ so much from total magnitudes.

For faint objects in the southern sky, the *ESO-LV* catalog is the obvious choice. In the north, Zwicky magnitudes are about all there is outside of the rich galaxy clusters, where papers in the journals should be consulted. Just remember these need adjustment upward (brighter) by about a full magnitude to make them approximate V_T. About 0.2 to 0.3 magnitude of this adjustment is for a rough zero-point correction from the Zwicky magnitudes to B_T. Add another 0.7 or 0.8 magnitude to correct the average galaxy from B_T to V_T. This works well enough at moderate to high galactic latitudes, where interstellar reddening is not significant.

As we saw in the first article in this series, Zwicky magnitudes for galaxies close to the Milky Way can be two or three magnitudes too faint (instead of just one) compared to V_T. This results from absorption by dust in our Galaxy, which dims blue light roughly three times more strongly that yellow light. Thus the Zwicky magnitudes near the galactic plane are less reliably converted to V_T, since the dust along the Milky Way is patchy and a blanket correction is not really possible. About all you can do with these galaxies to determine a visually-relevant magnitude is to go out either visually or with a photometer and look for yourself! □

Brian Skiff is an astronomer at Lowell Observatory and coauthor of the book Observing Handbook and Catalogue of Deep-Sky Objects *(Cambridge University Press, 1990).*

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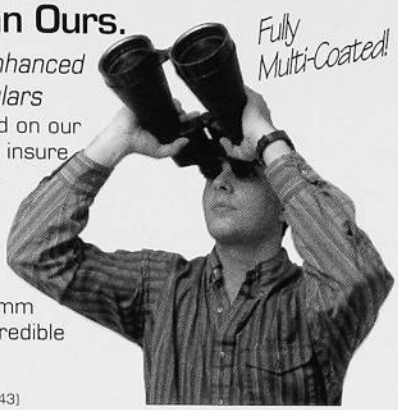

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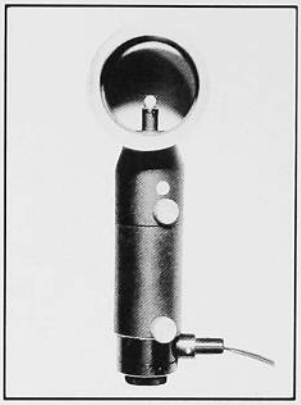

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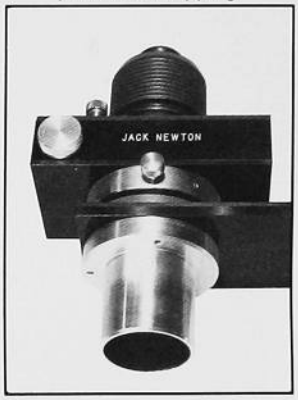

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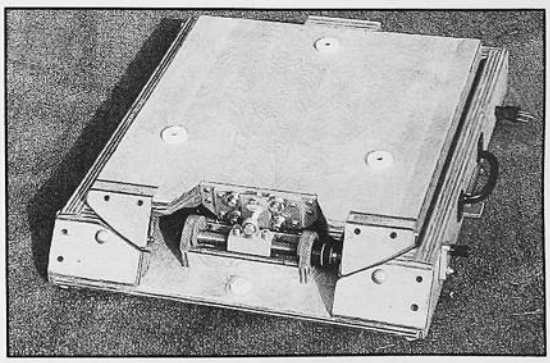

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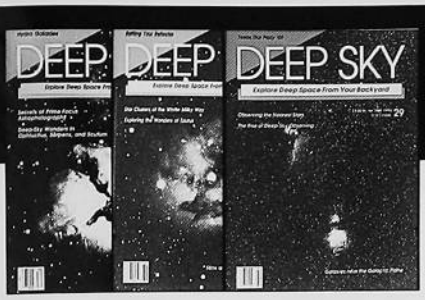

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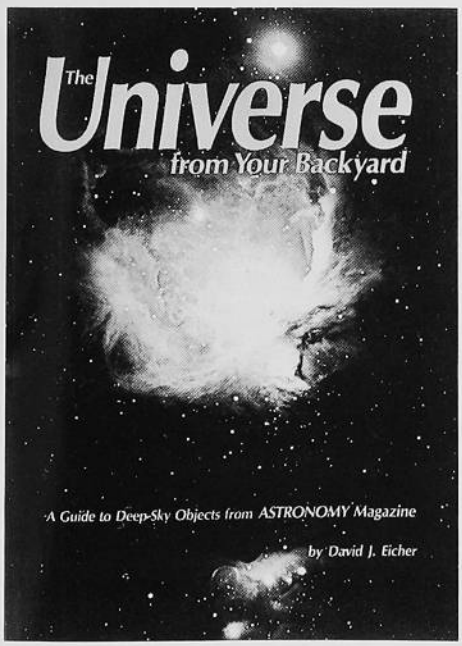

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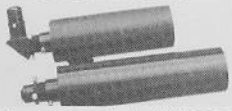

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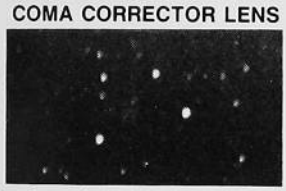


Coma 1 inch off-axis (17½" f/4.5)

Same Field with LUMICON coma corrector lens; note smaller, more numerous stars.

This computer-designed LUMICON 2" lens reduces coma and flattens the field for both viewing and photography. It threads into LUMICON 2" EASY-GUIDERS for effortless installation. This lens is optimized for f/4.5 and reduces aberrations for f/3.5 to f/5 Newtonians. Off-axis images are much smaller, making off-axis guiding far easier and yielding round pinpoint star images in photos. Since star images are sharp over a full 2¼" circle, you can use medium format cameras in addition to 35mm cameras. This zero power lens does not change image scale nor shift focus, and all lens surfaces are multi-coated for highest efficiency. Although designed for photography you may also use this lens to improve image quality in wide-field viewing with low power eyepieces.

LUMICON Coma Corrector/Field Flattener
2" lens **$285.00**
Extension tube for viewing **$26**
2" Easy-Guider™ (state camera) . . **$169.50**

NEW! ENCHANCED SILVER DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

LUMICON 1.3" & 3.1" enhanced silver diagonal mirrors & 2" star diagonal.
The new LUMICON diagonal mirrors have a special enhanced silver coating with a protective overcoating for long life. Visible reflectivity is 98-99% compared to 86-89% for standard aluminum coated mirrors. The extra 10-12% transmission is like adding an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

1.32" **$29.95** 1.52" **$34.50** 1.83" **$39.50**
2.14" **$49.50** 2.60" **$65.00** 3.10" **$89.50**

ENHANCED SILVER STAR DIAGONAL

90° star diagonals with above enhanced silver mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.
1¼" (1.32" mirror) **$99.50**
2" (1.83" mirror)(see photo above) . . **$159.00**

OXYGEN-III FILTER

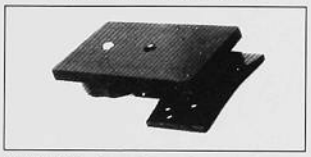
Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90% for both O-III lines at 496nm and 501nm.

Filter Type	1¼"	48mm
Lumicon Oxygen-III	$99.50	$199.50
Lumicon UHC	$99.50	$199.50
Lumicon Deep-Sky	$79.50	$119.50
Set UHC and Oxygen-III	$190.00	$380.00

NOTE: The Oxygen-III Filter is not a substitute, but a compliment to the UHC Filter. **1 year guarantee:** You must see nebulae with the O-III filter that are **invisible** without a filter.

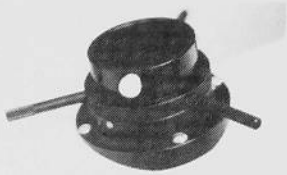
NEW ADJUSTABLE PIGGYBACK MOUNT



LUMICON has just designed a new adjustable piggyback mount ideal for all telescopes of 8-14" aperture. It has **both** vertical and sideways adjustment to allow optical alignment. It was designed to allow mounting of the LUMICON SUPER-FINDER on C-8, C-14, etc., but is ideal for any telephoto lenses or small telescopes.

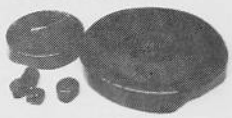
Deluxe Piggyback Mount **$54.00**
(State Telescope Type)
LUMICON 12x80mm SUPER-FINDER $195.00

NEW! LOW PROFILE HELICAL FOCUSERS



LUMICON® DELUXE NON-ROTATING HELICAL FOCUSER on a 6" telescope.
LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.
Select your desired base-plate shape!
Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD, SUPER-FINDER base plate.
LUMICON 1¼" Helical Focuser **$49.50**
LUMICON 2" Helical Focuser **$59.50**
LUMICON Non-rotating Helical Focuser $89.50
3 handles (see photo) for non-rotat. focuser **$12.95**
2" Rack & pinion low profile focuser . . . **$129.00**
2"/1¼" adapter w/48mm filter threads . . . **$20.00**
2" **LUMICON EASY-GUIDER** **$169.50**

PROTECTIVE DUST COVERS



Protective plugs (left), vinyl dust covers.
Protect your valuable telescope optics, eyepieces and accessories with these black vinyl covers. Add $1 shipping. Deduct 10%, 2 or more sets.

1¼" O.D. plug, seals focuser	4/$2		
2" O.D. plug	2/$2	3½" O.D. plug	$1.50
1¼", 1⅜"	3/$2	7½"	$8
1½"	2/$2	9½", 10.4"*	$12
2"	2/$2	12½", 12⅞"*	$15
3½", 4½"	$5	16"*	$20
5½"	$6	19" (DS-16)	$35
*Fits Odyssey		21" (Odyssey 17½)	$35

MAKE YOUR OWN ASTROGRAPH

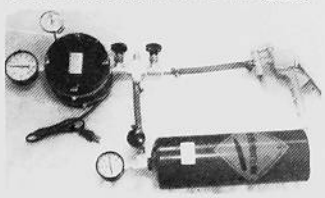
FILM HYPERSENSITIZATION KITS†

LUMICON HYPER-KITS™ yield 3-15X film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

†U.S. Patent 4,473,636

MAKE YOUR OWN HYPERED FILM

MODEL 300 HYPER-KIT sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds **$295.00**



MODEL 600 HYPER-KIT (See Photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates **$350.00**

MODEL 1200 HYPER-KIT is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller **$595.00**

Temperature controller for any HYPER-KIT **$65.00**

Electric Vacuum Pump **$319.00**

GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms of bright guide-starts. *Specify Camera and Telescope type.*
U.S. Patent #4,448,500

NEWTONIAN EASY-GUIDER™

Full aperture. Installs in secs. Specify 2" or 1¼".

NEWTONIAN EASY-GUIDER **$169.50**
3X Relay Diagonal (see photo) **$89.50**
Illuminated reticle eyepiece system . . **$99.50**
Guider for Hasselblad **$350**, Mamiya 645 **$199**

CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Dynamax-8. Includes 50mm achromatic lens for f/5.8 operation —3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER **$225.00**
Adapter for Hasselblad $185, Mamiya 645 **$98**

GIANT EASY-GUIDER™

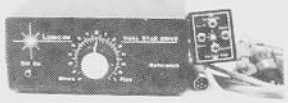
For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) . . . **add $99.95**
Adapter for Hasselblad adapter **$195,** Mamiya 645, **$119**

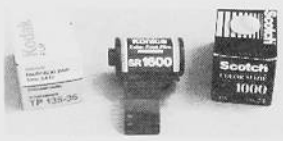
WHAT DO YOU NEED?

1. Illuminated reticle eyepiece **$99.50**
Lumicon 12mm eyepiece system has adjustable L.E.D. illumination, dual crosslines, battery pack.

2. Cable release for long exposures . . **$9.95**



3. **LUMICON Quartz Drive Corrector . $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.
Declination motor (state telescope) . . $99
NEW Deluxe Digital Qtz. Drive Correc. **$298**



HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).

Film Type, 35mm	Exposures	Price
2415, Ultra-fine B&W, red sens.	36	$10.95
SR3200, fastest of all, color neg	24	$13.95
Konica SR400, fine gr. color neg	12	$10.95
3M 1000, fastest slide film	20	$12.95
Fujichrome RD100, fine gr. slide	24	$12.95
5072, color slides from negs	36	$6.95
D-19 B&W Developer	1 gal.	$6.95

LUMICON®

2111 Research Drive #5T Livermore CA 94550
For phone orders please call (415) 447-9570
LUMICON Products catalogue $2.
Foreign orders add $8 ($20 for HYPER-KITS)
California Residents add 6% tax.
Prices subject to change w/o notice.

Paracorr™ Eats Coma

At Last, a *Universal* Coma Corrector for Parabolic Mirrors

There's no question large aperture reflectors like John Vogt's excellent 30" f/3.8 produce deep sky views rivaling those I've seen in major observatories. But his scope, like yours, is limited in field sharpness. The main offender is coma, an aberration which makes stars look like blurry comets. Visually and photographically, the faster the scope the worse the effect.

If we compensate for coma before starlight reaches the eyepiece, then the best eyepieces will be used to fullest advantage, and a sharp full frame 35mm photograph is possible. In sum, my design goals were:

1. maximum reduction in coma and field curvature without compromising spherical aberration and color correction

2. major sharpness improvement for all popular focal ratios

3. equally effective visually or for 35mm film

4. as convenient to use as a Barlow lens

I hope you agree that Paracorr, the coma eater, is the missing link necessary to fully enjoy your "DobNewt."

—Al Nagler

PARACORR™

The Formula For Increasing Sharp Field

A perfectly made 13" f/4.5 parabola has only about .1° diffraction-limited field. Now add Paracorr plus a Nagler eyepiece to your f/3.5 – f/8 parabola and tremendously increase your sharp field. Extract all the performance the atmosphere and your mirror quality will allow. Since Paracorr tightens and intensifies star images, enjoy resolving globular clusters as they drift right to the edge of your field of view. No more finding the "sweet spot" of focus. The entire field is your "sweet spot"!

Astrophotography

Rival a Schmidt Camera? Mount your 35mm SLR to Paracorr, and the quality of full frame photos will be spectacular since star image sizes are designed to be less than .001 inch over the field for an f/4.5 mirror.

Easy To Use

Paracorr drops in like a Barlow lens. With only a slight 1.15x magnifying factor, an f/4.5 telescope becomes an f/5.17. While optimized for Tele Vue eyepieces, other makes can be used. Of course the better the eyepiece, the better the results. The 1¼" Paracorr is parfocal with most Tele Vue eyepieces. The 2" Paracorr requires about ½" in-travel from your current focus location. Can't be simpler for any scope, any eyepiece, and any 35mm SLR camera.

Paracorr — The Missing Link

An optical chain is as good as its weakest link. With the development of 82° Nagler eyepieces, Tele Vue offers the largest, flattest and best corrected visual fields in the industry. Combine the Nagler revolution, Dobsonian revolution and Paracorr for the ideal mating for flat-field and sharpness, visually and photographically. Try Paracorr on your "DobNewt." We think you'll agree that the revolution is complete.

A) parfocal 2"-1¼" adapter
B) 2" eyepiece holder
C) lens assembly threaded for T-rings

2" Paracorr

1¼" Paracorr for visual use only.

Paracorr — More stars, sharper stars, more time to observe. Send $3 for full line literature package.

Tele Vue™

20 Dexter Plaza, Pearl River, NY 10965
(914) 735-4044